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ASSESSMENT OF ACCESSIBLE CONTAMINATION AT THE K-25 SITE. PHASE 3 REPORT: CUMULATIVE ANALYTICAL RESULTS

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K-25 Site
Oak Ridge, Tennessee

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NOTICE

This report contains all useful data from all phases of the study, including later evaluation of the data from prior phases. The following earlier reports gave interim results and interpretations, and are therefore superseded in their entireties by this report:

Contamination Assessment of the K–25 Site. Phase I Report: Preliminary Radionuclide Characterization. Draft, May 1991.

Contamination Assessment of the K–25 Site. Phase II Report: Further Analytical Results. Draft, January 1993.

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1.0 INTRODUCTION

1.1 Background

During the more than forty years of operations at the Oak Ridge Gaseous Diffusion Plant (K-25 Site), many thousands of tons of uranium were processed through the diffusion cascade. The vast majority of the uranium had been extracted and purified from ore, and so contained few or no non-uranium contaminants other than the very early decay daughters of uranium. However, some feed was recycled material obtained from spent reactor fuel. The impact of these "reactor returns" was to introduce appreciable quantities of radioactivity other than uranium to the Site, complicating radiological protection activities.

The recollections of informed long-term K-25 employees indicate that processing of reactor returns was intermittent, with campaigns conducted in the years 1952-1964, 1969-1974, and 1976-1977. The recycled uranium in the first campaign is said to have come entirely from plutonium production reactors at the Hanford and Savannah River Sites, with the feed in the latter campaigns including small portions from commercial reactors (including foreign reactors).

On an activity basis, the principal radionuclides expected to pass through chemical processing to contaminate the returns are the transuranic (TRU) radionuclides produced in highest abundance and with moderate half-lives: Np-237, Pu-238, Pu-239, Pu-240, and Am-241[1]. In addition, certain fission and activation products may form volatile compounds in the fluorination process: Tc-99, Ru-106, Sb-125, Cs-134, Cs-137. For example, some operational data from the 1950's and 1960's indicates the presence of detectable quantities of Zr-Nb-95, Ru-106, and Cs-137 in K-25 Site materials. However, because Zr-Nb-95, Ru-106, and Cs-134 have short half-lives (65 days, 368 days, and 2.1 years, respectively) compared to the 15+ years since recycled uranium was last introduced in 1977, they are unlikely to be present in significant quantities today.

From early operational days, the possible presence of these non-uranium contaminants at the gaseous diffusion plants was recognized, and occasional measurements of these radionuclides in various media were made. For example, K-25 plutonium urinalysis records (indicating negative results) exist from the early 1950's. In 1977, toward the end of the last recycled uranium campaign at K-25, special air samples were analyzed for Np, Pu, and Am. Controls were instituted based on the Np and Tc results.

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1. See "Historical Impact of Reactor Tails," Appendix D to:
D. A. Kucsmas and R. M. Tuft, *K-25 / K-27 Buildings Historical Characterization,* MMES Rept K/D-6052. September 1992.

However, sampling conducted during 1990 at the Paducah Gaseous Diffusion Plant (PGDP) suggested that the levels of transuranic contaminants at PGDP might be higher than previously estimated. Analysis of certain waste material specifically indicated significant Np–237, Am–241, and plutonium (in addition to uranium isotopes). Samples from selected areas of PGDP were then analyzed, and it was found that Np:U ratios were higher than expected, and were variable from location to location.

In response to the findings described above, a phased assessment program was undertaken at the gaseous diffusion plants, including the K–25 Site, to determine the magnitude of non-uranium radionuclides present in contamination in the process areas of the plants. The purpose of the assessment was to evaluate the potential impact of non-uranium radionuclides on the internal exposure control programs at the Site.

1.2 Limited Scope of the Assessment

THIS REPORT DOES NOT CONTAIN A COMPLETE ASSESSMENT OF ALL RADIOACTIVE CONTAMINATION AT THE K–25 SITE. It is confined to assessing results from samples of contamination that was exposed (i.e., accessible in routine activities) during the study period. Therefore, it is entirely possible that the interior surfaces of process equipment contain deposits of activity not represented in the samples reported here. However, the samples were collected from a broad cross-section of the areas where contamination was exposed during the study. Thus, they *are* likely to be representative of the materials one would encounter during everyday activities within the Site buildings where they were collected.

Any complete assessment of non-uranium contamination at the Site must include data from Non-Destructive Assay, results from any samples collected in the future from process equipment internals, and all other relevant information. A recommendation is made later in this report that a comprehensive database be created to include data from all such sources.

1.3 Contents of the Report

A Phase 1 report[2] presented the initial results of the non-uranium contamination assessment program for the K-25 Site. The main difficulties in drawing general conclusions from the Phase 1 data were the following:

- Because of the interest in obtaining results relatively quickly, Phase 1 samples were collected only in process areas of the plant that were then most frequently occupied or had on-going work, and were thought to have processed recycled uranium.

- Insufficient thought was given to obtaining the required sensitivity in TRU analyses, to permit the computation of U:TRU ratios at a high enough level and with an acceptable uncertainty. Many of the Phase 1 samples therefore contained insufficient total activity to provide useful data.

- No technetium data were obtained.

- Analytical results at or near the limit of sensitivity were captured and reported in ways that complicated the confident determination of U:TRU ratios for low-TRU samples.

Phase 2[3] attempted to rectify these shortcomings, as follows:

- Samples were collected from a larger cross-section of the K-25 Site.

- Samples were pre-screened at the K-25 Site to ensure that they contained enough alpha and/or beta activity to justify the time and expense of analyzing them. All isotopic uranium and TRU analyses were by radiochemical separation and alpha spectroscopy.

- Samples with sufficient excess beta activity were analyzed for Tc-99 by specific radiochemical separation and beta counting.

- Data reporting conventions were chosen to support the U:TRU ratio determination for samples of all activity levels.

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2. *Contamination Assessment of the K-25 Site. Phase I Report: Preliminary Radionuclide Quantification.* Draft, May 1991.

3. *Contamination Assessment of the K-25 Site. Phase II Report: Further Analytical Results.* Draft, January 1993.

- Some preliminary process history information was obtained to attempt the extrapolation of the measured results to points on the Site where samples were not collected in either Phase 1 or 2.

The Phase 2 results proved to be of adequate sensitivity and clarified Site conditions substantially. Therefore, Phase 3 was of limited scope. It was conducted to answer some specific questions growing out of the Phase 1 and 2 results, and to meet the needs of some later facility modification projects:

- What is the quantitative Tc-99:U ratio in the purge cascade areas, and how does it impact bioassay requirements?

- Because it is a new facility handling a wide variety of materials, what is the level of non-uranium contamination at the TSCA incinerator?

- Is there actually significant TRU contamination in parts of the K-25 building, or is the result from Unit 312-3 (Phase 2, Sample 123) a fluke?

- What levels of TRU prevail in feed, tails, or other high-probability areas where little or no sensitive data were accumulated during Phases 1 and 2? These included K-631, K-1231, K-1410, and the K-33 Feed Vaporization Room.

- How severe is the non-uranium contamination in the K-1420 building, which because of its role in equipment decontamination, contains activity collected from all over the Site?

This report contains the following:

- Section 2 summarizes the sampling and analysis process for the samples from all three phases.

- Section 3 derives the levels of TRU and Tc-99 to be treated as significant when evaluating the sample radiochemistry results, which are tabulated and evaluated in Appendix A.

- Section 4 presents and evaluates the gamma spectroscopy results from all phases and facilities.

- Section 5 collects information from Section 4 and Appendices A and B to centralize the available information about each building that was sampled during this assessment.

- Section 6 presents conclusions and recommendations.

2.0 SAMPLING AND ANALYSIS PROGRAM

Table 2-1 gives a general breakdown of the samples collected during this assessment. The following sub-sections describe the process through which the samples were collected and analyzed.

2.1 Phase 1

During May and June of 1990, 84 samples were collected from various former process areas of the K-25 Site where recycled uranium was known to have been processed. Appendix A includes a description of the useful samples from this group, listed by their K-25 sample identification numbers.

The samples were collected especially for the Phase 1 assessment, and were not routine job site characterization samples; rather, the approach was to select environments that were probably the most-contaminated ones accessible at the moment. Thus, the air samples were collected only in areas where maintenance or disassembly work was occurring at the time; since the cascades had not been operating for some years, the only places in the process areas with detectable airborne activity were those in which work was re-suspending contamination into the air. Smear sample locations within process or ventilation equipment similarly were selected based on their availability at the time: equipment that then was being disassembled or systems that then were being capped off or sealed up. Only samples on the outside of equipment, on floors, and in or on ventilation hoods represent normally-accessible work environments.

Air samples were collected only in forms that are normal for the K-25 Site operational program: 4-inch-diameter high-volume fiber filters; and 47-mm-diameter low-volume and personal air sample membrane filters. Some surface contamination was collected in small-area samples with 47-mm filter papers; other samples were collected over larger areas with large rectangles of Masslin cloth or other absorbent materials.

The samples were analyzed by what was then called the Environmental Survey and Site Assessment Program laboratory of Oak Ridge Associated Universities (ORAU), in Oak Ridge, TN. The results were transmitted in a series of seven letters from J.D. Berger of ORAU to D.R. Styers of K-25 Health Physics Department (letters dated July 16 to December 12, 1990).

Prior to detailed analysis, each sample was screened by ORAU for gross alpha and beta activity. This measurement was made primarily to facilitate laboratory contamination control, and was not a calibrated, reportable measurement. The reportable measurements were made by non-destructive gamma spectroscopy, and by radiochemistry with alpha spectroscopy.

All samples were analyzed as received, using high-resolution gamma spectrometers. The purpose of this measurement was to determine the presence of gamma-emitting fission and activation products, and to make a preliminary estimate of uranium isotopes and transuranic radionuclides. Those samples with gamma spectroscopy results indicating significant TRU content were dissolved and analyzed radiochemically for Np-237, Pu-238, Pu-239/240, and Am-241. Measurement of the purified TRU samples was by alpha spectroscopy using surface barrier detectors.

2.2 Phase 2

From August through October of 1991, 135 Phase 2 samples were collected from buildings throughout the K-25 Site, following the approximate distribution recommended in the Phase 1 report. Appendix A includes a description of these samples, listed by their K-25 sample identification numbers.

K-25 Site Health Physics Department (HPD) collected the samples especially for this assessment, and did not mix in routine job site characterization samples; rather, the approach was to select sample points that were probably the most-contaminated ones accessible at the moment. Almost all samples were smears, although a few miscellaneous items such as gloves or scraped-up deposits were also used. The technicians collecting the samples selected sample locations in the field, based on their availability at the time: equipment that then was being disassembled, systems that then were being capped off or sealed up, and contamination spots that happened to be exposed at the time. Only samples on the outside of equipment, on floors, and in or on ventilation hoods represent normally-accessible work environments.

Generally speaking, the technician surveyed a known contaminated area within a building to be sampled, to find the spot(s) with the highest total contamination levels. The technician collected one or more samples from these spots, attempting to collect as much activity as possible without regard to the size of the area smeared. K-25 Site HPD then screened each smear sample according to the criteria in Table 2-2 to ensure that it had an appropriate activity level: one which would yield acceptable sensitivity without introducing too much activity into the ORAU laboratories.

As in Phase 1, the Environmental Survey and Site Assessment Program laboratory of Oak Ridge Associated Universities (ORAU), in Oak Ridge, TN, analyzed the samples. J.D. Berger of ORAU transmitted the results in a series of letters to R.W. Oliver of K-25 HPD (letters dated October 25, 1991 to March 24, 1992).

ORAU first analyzed the designated samples as received, using high-resolution gamma spectrometers to determine the presence of gamma-emitting fission and activation products. Those samples which K-25 HPD had determined to have sufficient alpha activity were dissolved and analyzed radiochemically for U-234, U-235, U-238, Np-237,

Pu-238, Pu-239/240, and Am-241. Measurement of the purified U and TRU samples was by alpha spectroscopy using surface barrier detectors.

K-25 HPD also designated some of these same samples for Tc-99 analysis, based on a measured excess of gross beta over gross alpha activity. Because the front end of the Tc analysis is incompatible with the U/TRU analysis, ORAU first split these samples and analyzed one half for Tc-99 and the other for U and TRU. The ORAU Tc method involved a Tc-specific separation, followed by gross beta counting.

In contrast to the sampling and analysis methods used in Phase 1:

- No U or TRU analyses in Phase 2 employed gamma spectroscopy, since the Phase 1 experience showed that this technique yields results of insufficient sensitivity and reliability.

- ORAU reported the results of each Phase 2 sample analysis as a value and an uncertainty, avoiding all questions of how to deal with "less-than" values.

2.3 Phase 3

During August and September of 1992, 32 Phase 3 samples were collected from buildings around the K-25 Site, selected to answer the limited questions listed in Section 1.2, 1.3 above. Appendix A includes a description of these samples, listed by their K-25 sample identification numbers.

K-25 Site Health Physics Department (HPD) collected the samples according to the same general practices and protocol used in Phase 2, selecting sample points that were probably the most-contaminated ones accessible at the moment. All samples were either cloth smears or scraped-up deposits. All samples actually collected met the minimum and maximum activity criteria in Table 2-2.

A different analytical contractor, Lockheed Analytical Laboratories of Las Vegas, NV, was selected to analyze the Phase 3 samples. Lockheed's performance was found to be satisfactory on a suite of blank and spike samples, prior to being allowed to analyze the actual study samples. M. B. Ford of Lockheed transmitted the results in two reports (Lockheed file numbers 0830260 and 1020260 dated November 2, 1993 and December 16, 1993; supplemented by an additional letter of March 30, 1994).

All samples were subjected to all analyses: gamma ray spectroscopy for fission and activation products; and separative chemistry followed by appropriate counting for Tc-99, uranium isotopes, and transuranic radionuclides. Lockheed's performance on MMES-supplied QC samples inserted into the analytical batch was satisfactory to support the quality of the sample results.

Table 2-1. Breakdown of Samples Collected

Bldg.	Samples Collected					Samples Analyzed				
	Phase 1		Phase 2		Phase 3	by Radiochemistry				by Gamma Spec.
	Total	Low Act.[a]	Total	Low Act.[b]		Total	U	TRU	Tc	
K-25	13	13	9	6	8	11	11	11	9	25
K-27			9	7	4	6	6	6	5	6
K-29	4	1	8	0		11	11	10[c]	3	9
K-31	4	0	11	5		10	10	10	4	8
K-33	15	11	14	7	6	17	17	17	8	26
K-101			1	1		0				0
K-131			2	2		0				0
K-413			3	0		3	3	3	1	1
K-601			2	2		0				0
K-631			1	0	2	3	3	3	2	2
K-633			2	2		0				0
K-711			1	1		0				0
K-725			1	1		0				0
K-726			1	1		0				0
K-770			1	1		0				0
K-1004A	10	10	1	0		1	1	1	0	10
K-1004B			1	1		0				0
K-1004C			2	0		2	2	2	0	0
K-1004D			1	1		0				0

See notes on last page of table.

Table 2-1. (continued)

Bldg.	Samples Collected					Samples Analyzed				
	Phase 1		Phase 2		Phase 3	by Radiochemistry				by Gamma Spec.
	Total	Low Act.[a]	Total	Low Act.[b]		Total	U	TRU	Tc	
K-1004E			1	1		0				0
K-1004L			7	5		2	2	2	1	1
K-1006			3	2		1	1	1	1	1
K-1008C			1	1		0				0
K-1015			1	1		0				0
K-1025			5	5		0				0
K-1031			1	1		0				0
K-1037			2	1		1	1	1	0	0
K-1040			1	1		0				0
K-1059			1	1		0				0
K-1064			1	1		0				0
K-1066	2	1				1	1	1	0	2
K-1071			1	1		0				0
K-1098E			2	1		1	1	1	1	1
K-1131	3	0	1	0		4	4	4	1	4
K-1231			1	1	2	2	2	2	2	2
K-1232			1	1		0				0
K-1233			1	1		0				0
K-1300			3	3		0				0

See notes on last page of table.

Table 2-1. (continued)

Bldg.	Samples Collected					Samples Analyzed				
	Phase 1		Phase 2		Phase 3	by Radiochemistry				by Gamma Spec.
	Total	Low Act.[a]	Total	Low Act.[b]		Total	U	TRU	Tc	
K-1301			1	1		0				0
K-1302			1	1		0				0
K-1303			1	1		0				0
K-1401	13	12	6	6		1	1	1	0	13
K-1405			1	1		0				0
K-1407			1	1		0				0
K-1410			2	2	2	2	2	2	2	2
K-1413			2	2		0				0
K-1417			1	1		0				0
K-1419			1	1		0				0
K-1420	20	15	6	1	4	14	14	14	6	26
K-1421			1	1		0				0
K-1422			1	1		0				0
K-1423			2	2		0				0
K-1425			1	1		0				0
K-1435			2	2	4	4	4	4	4	4
Total[d]	84	63	135	91	32	97	97	96	50	143

See notes on last page of table.

Table 2-1. (Table Notation)

NOTE

As discussed further in the notes below, the fact that a given sample was collected but not analyzed does not mean that it contained no activity, nor does it indicate that there is little or no exposed or internal contamination in the building where the sample was collected. It merely indicates that the particular sample had too little total activity to permit an adequately sensitive determination of the ratio of uranium to specific non-uranium nuclides.

a. Phase 1 "Low Activity" samples were analyzed, and their results originally were presented in the Phase 1 report. However, their total activity was too near the limits of detection to permit determination of a reliable value of the U:TRU ratio. Specifically, they are those samples with less than 100 pCi total U. Analytical results from these samples are not treated further in this report.

b. Phase 2 "Low Activity" samples are those which did not meet the screening criteria for analysis, as given in Table 2-2. These samples are not treated further in this report.

c. One sample (Phase 3, number 1020) was spilled between completion of the uranium analysis and the completion of the TRU analysis.

d. The totals shown do not combine in a simple fashion because of different combinations of analyses being ordered on different samples in Phases 1 and 2.

Table 2-2. Sample Submission Criteria for Phase 2

ALPHA ANALYSIS CRITERIA	
α < 300 pCi:[a]	Activity too low for useful result. Do not process.
α > 50,000 pCi:	Activity too high for vendor to handle without risk of cross-contamination. Do not process.
Otherwise:	Request U isotopic, Np-237, Pu-238, Pu-239/240, Am-241.
BETA ANALYSIS CRITERIA	
(β - 2α) < 30 pCi:[b]	Activity too low for useful result. Do not process.
β > 50,000 pCi:	Activity too high for vendor to handle without risk of cross-contamination. Do not process.
Otherwise:[c]	Request Tc-99 and gamma spectroscopy.

a. Based on the following: The total of the MDAs for the four TRU analyses at ORAU is typically in the range of 0.2-0.75 pCi (depending among other things on whether the sample was first split for Tc analysis). The range of interest for U:TRU ratios extends to at least 200. If the TRU nuclides were reported at their respective limits of detection (totalling 0.75 pCi), and uranium were present at 300 pCi, the best estimate of the U:TRU ratio could be no lower than 300/0.75 = 400, which would be adequate for the purpose of this study.

b. Based on the following: Among the three natural uranium isotopes, the ratio of beta-to-alpha activity of the uranium and short-lived immediate daughters ranges from 2 (for U-238 plus Th-234 and Pa-234m) to 1 (for U-235 plus Th-231) to 0 (for U-234). Thus, in the worst case (depleted uranium), the quantity (β - 2α) represents the excess of beta activity over that which would be expected due to the uranium content. This excess could be all due to Tc-99, and the typical ORAU MDA for Tc-99 is in the range of 5-15 pCi.

c. Six samples with high gross beta activity but little or no gross alpha activity were nevertheless submitted for gamma spectroscopy only, under the assumption that they were promising candidates for the detection of any gamma-emitting fission and activation products.

3.0 DEFINITION OF SIGNIFICANT TRU AND TC-99 LEVELS

Before discussing the sample results, it is necessary to determine what level of non-uranium contamination would be significant if it were observed.

First, the absolute quantity of TRU (or Tc-99) present is not the determining factor in how to control a job or assess the hazard in an area. Given a level of non-uranium activity, it is always possible to define some level of uranium that, if it were present, would be the dominant hazard. That is, if one provided sufficient protection for this activity of uranium, one would in the process provide sufficient protection for the additional non-uranium activity. Therefore, the relevant quantity in deciding what level of controls should be applied is the ratio of U:TRU (or U:Tc-99) activity.

This section derives these ratios of interest.

3.1 Representative Mix of TRU Radionuclides at the Site

As will become clear below, the TRU radionuclides measured in this assessment do not have identical radiological impacts, especially as regards internal dosimetry. In order to compare "TRU" to uranium, it is then necessary to determine what nuclide or distribution of nuclides will be assumed in determining the significant U:TRU ratio for various purposes. This subsection addresses this question, and the following subsection derives the significant U:TRU ratios for specific radiation protection purposes.

There is no one mix or distribution of TRU nuclides found in every sample in this assessment. Table 3-1 conveys an idea of the variability of the distribution of TRU radionuclides observed in subsets of the results of this assessment.

Considering the variation in the data in the table, any selected distribution of TRU nuclides will be only a rough approximation of reality. However, for the purposes of deriving significant TRU levels, this report uses the following as a representative distribution:

Am-241: 20%	Pu-238: 10%
Np-237: 50%	Pu-239: 20%

Table 3-2 derives DAC and ALI values for this representative composite TRU mixture. The following sub-section uses these values.

3.2 Significant U:TRU Ratios

Table 3-3 compares limit parameters for uranium and for the representative mixture of TRU radionuclides, and shows the ratios of U:TRU activity at which TRU and U have equal impacts. For uranium to be the dominant hazard, the U:TRU ratio must be at least the following:

- For surface contamination samples, at least (2 × 50 =) 100. This is based on the ratios of the removable contamination limits, which weight TRU more heavily than the total contamination limits do.

- For air samples, at least (2 × 250 =) 500. This is based on the ratios of the DACs.

- For internal dosimetry planning, at least (2 × 250 =) 500. This is based on the ratios of the inhalation ALIs, which weight TRU more heavily than the ingestion ALIs do.

[Note that the above cutoff ratios for U:TRU assume an arbitrary factor of 2 to constitute "domination." This small a factor is appropriate because of the conservatism already inherent in setting these cutoffs based on the most unfavorable forms of U and TRU.]

3.3 Significant U:Tc-99 Ratios

This sub-section derives the significant ratios of U:Tc-99 by analogy with the preceding discussion on TRU. However, the Tc-99 situation is simpler, since it is only one radionuclide.

Table 3-4 compares limit parameters for uranium and Tc-99, and shows the ratios of U:Tc-99 activity at which Tc-99 and U have equal impacts. For uranium to be the dominant hazard, the U:Tc-99 ratio must be at least the following:

- For surface contamination samples, at least (2 × 1 =) 2. Both types of contamination limits are equal for U and Tc-99.

- For air samples, at least (2 × 0.002 =) 0.004. This is based on the ratios of the DACs.

- For internal dosimetry planning, at least (2 × 0.08 =) 0.16. This is based on the ratios of the ingestion ALIs, which weight Tc-99 more heavily than the inhalation ALIs do.

[Note that the above cutoff ratios for U:Tc-99 assume an arbitrary factor of 2 to constitute "domination." This small a factor is appropriate because of the conservatism already inherent in setting these cutoffs based on the most unfavorable forms of U and Tc-99.]

Table 3-1. Example Mixtures of TRU Radionuclides in Sample Results

Description	Number of Samples	Average Fraction of TRU Activity which is:			
		Am-241	Np-237	Pu-238	Pu-239/240
For buildings with 3 or more samples:					
K-25E	4	0.032	0.92	0.001	0.036
K-25W	7	0.027	0.80	0.089	0.080
K-27	6	0.12	0.62	0.12	0.14
K-29	10	0.46	0.24	0.22	0.087
K-31	10	0.40	0.31	0.14	0.15
K-33	17	0.18	0.62	0.087	0.11
K-413	3	0.31	0.38	0.22	0.095
K-631	3	0.25	0.66	0.017	0.066
K-1131	4	0.11	0.54	0.23	0.12
K-1420	14	0.12	0.34	0.052	0.48
K-1435	4	0.12	0.27	0.099	0.51
For the three Phases of the assessment:					
Phase 1	21	0.22	0.43	0.19	0.16
Phase 2	43	0.34	0.37	0.11	0.18
Phase 3	32	0.081	0.62	0.037	0.26
For the entire assessment:					
Overall	96	0.23	0.47	0.10	0.20

Note: All averages in this table are unweighted arithmetic means of the fractions in the respective samples. When computing the fraction of a given nuclide in a given sample, a negative result was treated as 0.0, leading to a 0.0 fraction for that nuclide in that sample.

Table 3-2. Calculation of Composite Parameters for Representative TRU Mixture

Parameter	Am–241	Np–237	Pu–238	Pu–239/240	Composite
Fraction in Representative Mixture	0.2	0.5	0.1	0.2	1.0
Most Restrictive DAC (Bq/m^3)	0.08 [Class W]	0.09 [Class W]	0.09 [Class W]	0.08 [Class W]	0.08
Most Restrictive Ingestion ALI (Bq)	5 E+4 [f1 = 5E-4]	3 E+3 [f1 = 1E-2]	3 E+5 [f1 = 1E-4]	2 E+5 [f1 = 1E-4]	8 E+4
Most Restrictive Inhalation ALI (Bq)	200 [Class W]	200 [Class W]	200 [Class W]	200 [Class W]	200

Notes:

1. For each given parameter in this table, a lower value is more restrictive. Each value of a given parameter is the most restrictive choice available for the given radionuclide, to maximize the importance of TRU relative to U. Text in [] denotes which form of the given radionuclide applies to the parameter value shown.
2. DACs and ALIs are taken from the appropriate Supplements to: *Limits for Intakes of Radionuclides by Workers*, ICRP Publication 30, July 1978.
3. The composite value of each parameter is the arithmetic mean of the individual radionuclide values, as weighted by the fraction of each nuclide in the assumed representative mixture. The result is rounded down to one significant figure.

Table 3-3. Significant Ratios of U to TRU

Limit	Composite TRU	Uranium	U:TRU Ratio for Equal Impacts
Removable contamination (dpm/100 cm^2)	20	1000	50
Total contamination (dpm/100 cm^2)	300	5000	17
DAC (Bq/m^3)	8 E-02	2 E+01 [all / Class D]	250
Ingestion ALI (Bq)	8 E+04	8 E+06 [-238 / f1=00.05]	100
Inhalation ALI (Bq)	2 E+02	5 E+04 [all / Class D]	250

Notes:

1. For each given parameter in this table, a lower value is more restrictive. Each value of a given parameter is the least restrictive choice available for U, to maximize the importance of the TRU. Text in [] denotes which isotope and form of U applies to the parameter value shown.
2. Contamination limits are taken from *Martin Marietta Energy Systems Radiological Control Manual*, December 1992. Uranium DACs and ALIs are taken from *Limits for Intakes of Radionuclides by Workers*, ICRP Publication 30 Supplement to Part 1, July 1978. DAC and ALI for the representative TRU mixture is from Table 3-2 above.

Table 3-4. Significant Ratios of U to Tc–99

Limit	Tc–99	Uranium	U:Tc–99 Ratio for Equal Impacts
Removable contamination (dpm/100 cm^2)	1000	1000	1.0
Total contamination (dpm/100 cm^2)	5000	5000	1.0
DAC (Bq/m^3)	1 E+04 [Class W]	2 E+01 [all / Class D]	0.002
Ingestion ALI (Bq)	1 E+08	8 E+06 [-238 / f1=00.05]	0.08
Inhalation ALI (Bq)	2 E+07 [Class W]	5 E+04 [all / Class D]	0.0025

Notes:

1. For each given parameter in this table, a lower value is more restrictive. Each value of a given parameter is the mo restrictive choice available for Tc–99, and the least restrictive choice available for U, to maximize the importance of the Tc–99. Text in [] denotes which form of Tc–99, or which isotope and form of U, applies to the parameter value shown.
2. Contamination limits are taken from *Martin Marietta Energy Systems Radiological Control Manual*, December 1992. DACs and ALIs are taken from the appropriate supplements to: *Limits for Intakes of Radionuclides by Workers*, ICRP Publication 30, July 1978.

4.0 GAMMA-EMITTER DATA AND RESULTS

4.1 Phase 1

None of the Phase 1 samples contained detectable gamma ray-emitting fission or activation products.

4.2 Phase 2

By contrast, ORAU reported fission and activation product activity exceeding the MDA in eight of the 27 Phase 2 samples on which gamma ray spectroscopy was performed.

Table 4-1 summarizes the reported activities for the eight samples with reported activities above MDA. Table 4-2 contains the complete list of non-background radionuclides included in the gamma spectroscopy library used to analyze the Phase 2 samples.

Three arguments suggest that the activities reported are not actually due to the radionuclides to which they are attributed:

- The reported gamma emitters appear only in high-alpha samples. Of the six samples submitted for gamma-only analysis (because they had high gross beta but low gross alpha activity), the peak search and nuclide identification software reported only one gamma emitter in one sample (Eu-155 in sample 55); even that one radionuclide was reported at a level less than half of its MDA. This observation is consistent with the hypothesis that the reported activities are actually due to low-abundance unresolved gamma interferences from uranium or TRU radionuclides.

- The two most-reported gamma-emitters, Co-57 and Nb-95, have half-lives less than a year (as does the Zr-95 parent of Nb-95). If these radionuclides were residual contamination from reactor returns uranium last introduced at the K-25 Site 15 years ago, they would have to have been present initially in extremely high activities to still be detectable.

- Most of the identified radionuclides can be accounted for by specific interferences from uranium isotopes and their daughters, or by unintended results of the gamma spectroscopy software, as follows.

    - In the one occurrence of "Co-60" only one of the two prominent Co-60 peaks was observed, and that peak had a very small area.

    - "Nb-95" was identified and quantified based only on the presence of a peak at 766 keV; this is also a prominent peak in the spectrum of the U-238 daughter Pa-234m.

- "Eu-152" was identified based on the occurrence of only two of its four prominent lines, and the two lines which were present yielded Eu-152 activity estimates that differed by a factor of almost 1000.

- "Eu-155" was identified and quantified based on peaks near 86 and 105 keV; these are respectively lines that occur in the decays of Th-231 and U-235.

- Instances of "Co-57," "Eu-152," and "Eu-154" are all attempts by the gamma spectroscopy software to account for the occurrence of a 122-keV peak, with the specific identification made by the software in a given case depending on what other lines are also in the spectrum. No explanation for this peak is immediately apparent, although it does correlate strongly with the U-235 content of the sample. The short-lived activation product Co-57 is almost certainly *not* the true explanation for these observations.

Considering the above facts, for the buildings sampled in Phases 1 and 2, there are no measurements to support a claim of significant gamma-emitting contamination at the K-25 Site other than that due to uranium or TRU radionuclides (or their immediate daughters).

4.3 Phase 3

Lockheed detected gamma emitters above MDA in 3 of the 32 Phase 3 samples. In all cases, the only detectable gamma emitter was Cs-137. Table 4-3 summarizes the results.

No obvious reason exists to discount the spectral analyses: the peaks in question are well-formed and distinct; the results are large compared to their respective uncertainties; other peaks in the spectra are positioned correctly for the prevailing energy calibration; no other natural radionuclide or common fission or activation product produces a peak at the 662-keV energy of Cs-137; and all other significant peaks in the spectra are accounted for. The presence of Cs-137 is not incredible: the half-life of Cs-137 is more than adequate for it to persist to the present; and the three buildings in question (K-27, K-1231, and K—1410) all processed significant amounts of returns material, as evidenced by the readily-detectable levels of TRU and Tc-99 in the same three samples. Two of the three buildings involved had not been sampled in Phases 1 and 2.

Therefore, it is entirely possible that reported results do reflect the presence of Cs-137 in the three samples. However, the levels detected in these samples would have no practical impact on operations or decision-making. Table 4-4 summarizes the limits applicable to Cs-137 and to U, and shows that (regardless of the purpose) U will have equal impact with Cs-137 whenever there is at least 2.0 times as much U as Cs-137. In view of the fact that the measured uranium activities in these samples are 16 to 790 times the Cs-137 activities, the U hazard clearly dominates in all cases.

4.4 Summary

Only one gamma-emitting fission or activation product, Cs-137, was reliably detected in contamination samples at the K-25 Site. It was found in only three samples, all from Phase 3.

In every case, and for all purposes, the hazard from the uranium activity present far outweighs that from the Cs-137. Therefore, given the results available to date, the impact of the possible presence of fission or activation products other than Tc-99 is negligible throughout the K-25 Site.

Table 4-1. Reported Gamma-Emitter Activities for Phase 2 Samples

Sample No.	Reported Activity (pCi)							
	Co-57	Co-60	Nb-95	Eu-152	Eu-154	Eu-155	Total U	Total TRU
19	7.9		31.9				9290	0.750
24		6.4	9.1				495	0.170
61	1.4		9.6				2280	0.310
115	15.8		99.7		30		37300	80.5
121			18.5				2870	3.43
124	2893		30	7976			7.74 E+06	6840
125			10				1670	2.62
1105	88					320	2.08 E+05	3.32

Notes: Only gamma emitter results greater than their respective MDA are included in this table. Total U and TRU activities are provided for comparison only. Full descriptive information and assay results for U and TRU are presented in Appendix A.

Table 4-2. Radionuclides in the Gamma Spectroscopy Library

Reported above MDA at Least Once	
Radionuclide	Half-Life (y)
Co-57	0.74
Co-60	5.27
Nb-95	0.10
Eu-152	13.6
Eu-154	8.8
Eu-155	4.96

Never Reported Above MDA	
Radionuclide	Half-Life (y)
Mn-54	0.86
Fe-59	0.12
Zn-65	0.67
Sr-85	0.18
Zr-95	0.18
Ag-110m	0.68
Sb-124	0.16
Sb-125	2.77
Ba-133	10.5
Cs-134	2.06
Cs-137	30.17
Ce-144	0.78

Note: Only non-background radionuclides are listed.

Table 4-3. Reported Cs-137 Activities for Phase 3 Samples

Sample No.	Bldg.	Reported Activity (pCi)			
		Cs-137	Tc-99	Total U	Total TRU
9	K-27	9.92 ± 0.51	304	7860	1.86
21	K-1231	10.1 ± 0.6	387	2010	6.78
24	K-1410	98.6 ± 2.6	249	1540	13.3

Notes: Only gamma emitter results greater than their respective MDA are included in this table. Tc-99, U, and TRU activities are provided for comparison only. Full descriptive information and assay results for Tc-99, U, and TRU are presented in Appendix A.

Table 4-4. Comparison of Limits Applicable to Cs-137 and Uranium

Limit	Cs-137	Uranium	U:Cs-137 Ratio for Equal Impacts
Removable contamination (dpm/100 cm^2)	1000	1000	1.0
Total contamination (dpm/100 cm^2)	5000	5000	1.0
DAC (Bq/m^3)	2 E+03	2 E+01 [all / Class D]	0.01
Ingestion ALI (Bq)	4 E+06	8 E+06 [-238 / f1=0.05]	2.0
Inhalation ALI (Bq)	6 E+06	5 E+04 [all / Class D]	0.008

Notes:

1. For each given parameter in this table, a lower value is more restrictive. Each value of a given parameter is the most restrictive choice available for Cs-137, and the least restrictive available for U, to maximize the importance of the Cs-137. Text in [] denotes which isotope and form of U applies to the parameter value shown.
2. Contamination limits are taken from *Martin Marietta Energy Systems Radiological Control Manual*, December 1992. DACs and ALIs are taken from *Limits for Intakes of Radionuclides by Workers*, ICRP Publication 30 Supplement to Part 1, July 1978.

5.0 DISCUSSION OF RESULTS BY BUILDING

Appendix A contains the results of the sample assays for each building or facility, and a discussion of how to interpret them. Appendix B summarizes the history of the diffusion cascade and primary process support buildings at the Site.

The sections that follow discuss each sampled building or facility separately, including its history and status, and a summary and analysis of its sample results for gamma emitters, Tc-99 and TRU. Any comments presented in regard to the significance of these non-uranium contaminants are with reference to the significant levels developed above in Sections 3.0 and 4.0.

5.1 K-25 (East)

Status: Shutdown

History:

Sections 309, 310:	1945-1948, feed and stripper sections.
	1948-1964, low-moderate enrichment sections.
Unit 311-1:	1945-1952, bottom stripper unit in cascade.
	1952-1977, side purge unit.
Other units:	1945-1964, low-moderate enrichment units.

Gamma Emitting Fission and Activation Products

None detected in the 15 samples analyzed.

Technetium-99

Samples analyzed	4
Lowest measured U:Tc-99 ratio	0.0109 ± 0.0005

Discussion: The Tc-99 sample results in the K-25 East Wing are actually in two classes. The two samples from K-311-1 have (as expected) U:Tc-99 ratios less than 1.0. The two samples from outside K-311-1, both from K-310, have (as expected) higher U:Tc-99 ratios.

Transuranics

Samples analyzed	4
Lowest measured U:TRU ratio	126 ± 32
Highest measured U:TRU ratio	1890 ± 100
Mean U:TRU ratio	900
Samples with ratio < 500	2 of 4

Discussion: The TRU sample results in the K-25 East Wing are all dominated by Np-237, and fall into two classes. The two samples from K-311-1 have U:TRU ratios between 100 and 500. The two samples from outside K-311-1, both from K-310, have higher U:TRU ratios.

5.2 K-25 (West)

Status: Shutdown since 1964

History:

Section 304:	1945-1964, low-moderate enrichment units.
Section 305:	1957-1964, top enrichment section after 306 shutdown.
Section 306:	1945-1957, top enrichment section. Shutdown afterwards.
Section 312:	1945-1964, side and top purge units. Shutdown afterwards.

Gamma Emitting Fission and Activation Products

None detected in the 10 samples analyzed.

Technetium-99

Samples analyzed	5
Lowest measured U:Tc-99 ratio	174 ± 48

Transuranics

Samples analyzed	7
Lowest measured U:TRU ratio	61.7 ± 4.8
Highest measured U:TRU ratio	62500 ± 3400
Mean U:TRU ratio	9760
Samples with ratio < 500	1 of 7

Discussion: The TRU sample results in the K-25 West Wing are all dominated by Np-237, and fall into two classes. The four samples from Section 312 include the only one from K-25W having a U:TRU ratio less than 500. [As in K-25E, the samples with low U:TRU ratios are from units associated with purge activities.] The three samples from outside K-312 have higher U:TRU ratios.

5.3 K-27

Status: Shutdown

History:

Unit 402-1:	Stripper. 1952-1964, bottom stripper unit in cascade.
Units 402-8 and -9:	1948-1964, low enrichment units.
	1964-1977, idle.
	1977-1985, purge and pigtail units.
Other units:	1945-1964, low-moderate enrichment units.

Gamma Emitting Fission and Activation Products

Cs-137 detected above MDA in one of the six samples analyzed (Phase 3, No. 9). In that sample, the U:Cs-137 ratio was 792, indicating that U is the dominant hazard for all purposes.

Technetium-99

Samples analyzed	5
Lowest measured U:Tc-99 ratio	0.0146 ± 0.0002

Discussion: Phase 2 Sample 1013 (Unit 402-4) yields a surprising result: it has the lowest U:Tc-99 ratio in K-27; but the unit where it was taken is not currently posted as a Tc-99 area, and it has no known specific historic association with the purge units where Tc-99 is most common on the Site. Phase 3 Sample 12 (Unit 402-9) has one of the largest absolute quantities of Tc-99 of all samples collected anywhere on the Site, but not a very low U:Tc-99 ratio (0.51); this unit was the top purge of the shortened cascade in 1977-1985, and is currently posted as a Tc-99 area.

Transuranics

Samples analyzed	6
Lowest measured U:TRU ratio	398 ± 250
Highest measured U:TRU ratio	41800 ± 16000
Mean U:TRU ratio	8800
Samples with ratio < 500	1 of 6

Discussion: As discussed just above, Phase 2 Sample 1013 (Unit 402-4) yields the surprising result of the lowest U:Tc-99 ratio in K-27, despite the fact that the unit where it was taken has no known specific historic association with the purge processes. Its TRU result is also like the TRU results of the purge units in the K-25 building: it is dominated by Np-237 and has a U:TRU ratio less than 500. All other samples from K-27 have U:TRU ratios greater than 500, including the samples from former purge units K-402-8 and -9.

5.4 K-29

Status: Shutdown

History: 1951-1985, feed-low enrichment units.

Gamma Emitting Fission and Activation Products

None detected in the 9 samples analyzed.

Technetium-99

Samples analyzed	3
Lowest measured U:Tc-99 ratio	0.00258 ± 0.00004

Discussion: Samples collected throughout K-29 have some of the largest absolute quantities of Tc-99, and some of the lowest U:Tc-99 ratios, of samples collected anywhere on the Site.

Transuranics

Samples analyzed	10
Lowest measured U:TRU ratio	145 ± 29
Highest measured U:TRU ratio	12400 ± 2400
Mean U:TRU ratio	3400
Samples with ratio < 500	3 of 10

Discussion: The three samples from K-29 that exhibit U:TRU ratios less than 500 were all collected from within ventilation ducts during the disassembly of those structures. No samples from within the ducts had *high* U:TRU ratios, and no samples from outside the ducts had *low* U:TRU ratios.

5.5 K-31

Status: Shutdown

History:

Units 302-3.x and above:	1952-1985, slightly enriched units.
Units below 302-3.x:	1952-1985, slightly depleted units.
	1964-1985, bottom of K-31 was bottom stripper.

Gamma Emitting Fission and Activation Products

None detected in the 8 samples analyzed.

Technetium-99

Samples analyzed	4
Lowest measured U:Tc-99 ratio	0.575 ± 0.008

Transuranics

Samples analyzed	10
Lowest measured U:TRU ratio	169 ± 47
Highest measured U:TRU ratio	58800 ± 87000
Mean U:TRU ratio	13500
Samples with ratio < 500	3 of 10

Discussion: The three samples from K-29 that exhibit U:TRU ratios less than 500 were all collected from within ventilation ducts during the disassembly of those structures. No samples from outside the ducts had low U:TRU ratios, and three of the four samples from inside the ducts did have low U:TRU ratios.

5.6 K-33

Status: Shutdown

History: 1954-1985, near-feed enrichment units.

Gamma Emitting Fission and Activation Products

None detected in the 26 samples analyzed.

Technetium-99

Samples analyzed	8
Lowest measured U:Tc-99 ratio	6.80 ± 0.12

Discussion: Tc-99, while detectable above MDA in samples from this building, is completely negligible compared to uranium for all purposes. However, because of the sheer quantity of Tc-99 present in certain areas of the building, it may be prudent to require Tc-99 bioassay of workers who enter those portions of the building.

Transuranics

Samples analyzed	17
Lowest measured U:TRU ratio	132 ± 81
Highest measured U:TRU ratio	31700 ± 10000
Mean U:TRU ratio	4500
Samples with ratio < 500	2 of 17

Discussion: The two Phase 3 samples from the Feed Vaporization Room (Phase 3 samples 15 and 16) did not confirm the one Phase 1 result from that room (Phase 1 sample S02) which showed a low U:TRU ratio. The other K-33 sample with a low U:TRU ratio is a Phase 1 duct sample, which repeats a pattern found in other cascade buildings.

5.7 K–413

Status: Shutdown

History: 1964-1985, low-moderate enrichment product withdrawal facility.

Gamma Emitting Fission and Activation Products

None detected in the one sample analyzed.

Technetium–99

Samples analyzed	1
Lowest measured U:Tc-99 ratio	2.46 ± 0.04

Discussion: Tc–99, while detectable above MDA in samples from this building, is completely negligible compared to uranium for all purposes.

Transuranics

Samples analyzed	3
Lowest measured U:TRU ratio	610 ± 650
Highest measured U:TRU ratio	16700 ± 2900
Mean U:TRU ratio	6660
Samples with ratio < 500	0 of 3

Conclusion:

TRU (Am–241 and Np–237 only) is barely detectable above MDA in the samples from this building. The total TRU is completely negligible compared to uranium for all purposes.

5.8 K-631

Status: Shutdown

History: 1946-1962, tails withdrawal.
1962-1985, surge capacity at bottom of cascade.

Gamma Emitting Fission and Activation Products

None detected in the 2 samples analyzed.

Technetium-99

Samples analyzed	2
Lowest measured U:Tc-99 ratio	113 ± 7

Discussion: Tc-99, while detectable above MDA in samples from this building, is completely negligible compared to uranium for all purposes.

Transuranics

Samples analyzed	3
Lowest measured U:TRU ratio	6200 ± 1300
Highest measured U:TRU ratio	14900 ± 3800
Mean U:TRU ratio	9200
Samples with ratio < 500	0 of 3

Discussion: TRU, while detectable above MDA in samples from this building, is completely negligible compared to uranium for all purposes.

5.9 K-1004A

Status: Active

History: Laboratory

Gamma Emitting Fission and Activation Products

None detected in the 10 samples analyzed.

Technetium-99

There is no historical reason to suspect Tc-99 contamination in this building, and no samples were found with unexplained high beta activity. Therefore, no samples were analyzed for Tc-99.

Transuranics

Samples analyzed	1
Lowest measured U:TRU ratio	3950 $\pm$ 1200
Samples with ratio < 500	0 of 1

Discussion: TRU, while detectable above MDA in the one sample from this building, is completely negligible compared to uranium for all purposes.

5.10 K-1004C

Status: Active

History: Laboratory

Gamma Emitting Fission and Activation Products

No samples analyzed by gamma spectroscopy.

Technetium-99

There is no historical reason to suspect Tc-99 contamination in this building, and no samples were found with unexplained high beta activity. Therefore, no samples were analyzed for Tc-99.

Transuranics

Samples analyzed	2
Lowest measured U:TRU ratio	2310 ± 330
Highest measured U:TRU ratio	36400 ± 15000
Samples with ratio < 500	0 of 2

Discussion: TRU (Am-241 only) is detectable above MDA in the samples from this building. The total TRU is completely negligible compared to uranium for all purposes.

5.11 K-1004L

Status: Active

History: Laboratory

Gamma Emitting Fission and Activation Products

None detected in the one sample analyzed.

Technetium-99

Samples analyzed	1
Lowest measured U:Tc-99 ratio	1640 ± 410

Discussion: Tc-99, while detectable above MDA in samples from this building, is completely negligible compared to uranium for all purposes.

Transuranics

Samples analyzed	2
Lowest measured U:TRU ratio	2200 ± 990
Highest measured U:TRU ratio	32800 ± 11000
Samples with ratio < 500	0 of 2

Discussion: TRU (Am-241 and Np-237 only) was barely detectable above MDA, and in only one of the two samples from this building. The total TRU is completely negligible compared to uranium for all purposes.

5.12 K-1006

Status: Active

History: Laboratory. Known Tc-99 spill and ongoing work in C-Wing.

Gamma Emitting Fission and Activation Products

None detected in the one sample analyzed.

Technetium-99

Samples analyzed	1
Lowest measured U:Tc-99 ratio	Tc-99 not detectable

Discussion: Despite the process history of a Tc-99 spill in K-1006 Room C107, removable Tc-99 was not detected in the sample taken there. Therefore, any controls based on Tc-99 may be reserved for activities that might be expected to disturb fixed Tc-99 deposits, or in which loose Tc-99 is being handled.

Transuranics

Samples analyzed	1
Lowest measured U:TRU ratio	634 ± 59
Samples with ratio < 500	0 of 1

Discussion: TRU, while detectable above MDA in samples from this building, is completely negligible compared to uranium for all purposes.

5.13 K-1037

Status: Active

History: Originally, barrier manufacture facility. Later, AVLIS experiment facility.

Gamma Emitting Fission and Activation Products

No samples analyzed by gamma spectroscopy.

Technetium-99

There is no historical reason to suspect Tc-99 contamination in this building, and no samples were found with unexplained high beta activity. Therefore, no samples were analyzed for Tc-99.

Transuranics

Samples analyzed	1
Lowest measured U:TRU ratio	1390 ± 280
Samples with ratio < 500	0 of 1

Discussion: TRU, while detectable above MDA in samples from this building, is completely negligible compared to uranium for all purposes.

5.14 K-1066

Status: Active

History: UF_6 Cylinder Storage Yard

Gamma Emitting Fission and Activation Products

None detected in the two samples analyzed.

Technetium-99

There is no historical reason to suspect Tc-99 contamination in this yard, and no samples were found with unexplained high beta activity. Therefore, no samples were analyzed for Tc-99.

Transuranics

Samples analyzed	1
Lowest measured U:TRU ratio	520 ± 300
Samples with ratio < 500	0 of 1

Discussion: TRU was not detectable above MDA in the one sample from this yard. Total TRU activity was completely negligible compared to uranium for all purposes.

5.15 K-1098E

Status: Active

History: Originally, sand blasting facility for process equipment
Currently, storage space

Gamma Emitting Fission and Activation Products

None detected in the one sample analyzed.

Technetium-99

Samples analyzed	1
Lowest measured U:Tc-99 ratio	121 ± 19

Discussion: Tc-99, while detectable above MDA in samples from this building, is completely negligible compared to uranium for all purposes.

Transuranics

Samples analyzed	1
Measured U:TRU ratio	1870 ± 580
Samples with ratio < 500	0 of 1

Discussion: TRU (Pu-239/-240 only) was barely detectable above MDA in the one sample from this building. The total TRU was completely negligible compared to uranium for all purposes.

5.16 K-1131

Status: Shutdown

History: 1952-1961, UF_6 production from natural, returns, and recycle oxides.
1962-1985, feed vaporization and tails withdrawal.

Gamma Emitting Fission and Activation Products

None detected in the four samples analyzed.

Technetium-99

Samples analyzed	1
Lowest measured U:Tc-99 ratio	32.8 ± 1.7

Discussion: Tc-99, while detectable above MDA in samples from this building, is completely negligible compared to uranium for all purposes.

Transuranics

Samples analyzed	4
Lowest measured U:TRU ratio	51 ± 48
Highest measured U:TRU ratio	837 ± 57
Mean U:TRU ratio	320
Samples with ratio < 500	3 of 4

Discussion: The samples from K-1131 consistently exhibit some of the lowest U:TRU ratios on the entire Site. This would be consistent with the hypothesis that TRU fluorine compounds would be less likely to be volatile than uranium hexafluoride, and so would tend to concentrate in a facility used at various times for UF_6 production and vaporization.

5.17 K-1231

Status: Shutdown

History: Uranium recovery from fluorination ashes and decontamination solutions, prior to commissioning of K-1420.

Gamma Emitting Fission and Activation Products

Cs-137 detected above MDA in one of the two samples analyzed (Phase 3, No. 21). In that sample, the U:Cs-137 ratio was 199, indicating that U is the dominant hazard for all purposes.

Technetium-99

Samples analyzed	2
Lowest measured U:Tc-99 ratio	0.0121 ± 0.0005

Discussion: Despite the fact that K-1231 is not now posted as a Tc-99 Area, its process history as the uranium recovery plant accords with the possible presence of Tc-99 there. Indeed, one of the two samples collected *did* contain Tc-99 in amounts significant compared to uranium, for some purposes.

Transuranics

Samples analyzed	2
Lowest measured U:TRU ratio	296 ± 24
Highest measured U:TRU ratio	589 ± 300
Mean U:TRU ratio	440
Samples with ratio < 500	1 of 2

Discussion: U:TRU ratios in the two samples from K-1231 are low enough that even the average value is below the significant ratio of 500.

5.18 K-1401

Status: Active

History: Mechanical Maintenance Shop

Gamma Emitting Fission and Activation Products

None detected in the 13 samples analyzed.

Technetium-99

No samples from this building were found with unexplained high beta activity. Therefore, no samples were analyzed for Tc-99.

Transuranics

Samples analyzed	1
Measured U:TRU ratio	334 ± 71

Discussion: Because of the amount of in-situ sealing that has taken place in this building, it is difficult to obtain a high-activity smear sample for TRU analysis. The one sample analyzed did have a rather low U:TRU ratio. Since the Shop services equipment from throughout the Site, it is reasonable to expect at least local deposits to be relatively high in TRU.

5.19 K-1410

Status: Shutdown

History: Equipment decontamination and plating, prior to commissioning of K-1420.

Gamma Emitting Fission and Activation Products

Cs-137 detected above MDA in one of the two samples analyzed (Phase 3, number 24). In that sample, the U:Cs-137 ratio was 15.6, indicating that U is the dominant hazard for all purposes.

Technetium-99

Samples analyzed	4
Lowest measured U:Tc-99 ratio	6.17 ± 0.36

Discussion: Tc-99, while detectable above MDA in samples from this building, is completely negligible compared to uranium for all purposes.

Transuranics

Samples analyzed	2
Lowest measured U:TRU ratio	115 ± 8
Highest measured U:TRU ratio	13400 ± 3000
Mean U:TRU ratio	6800
Samples with ratio < 500	1 of 2

5.20 K-1420

Status: Active

History: Equipment decontamination and plating, and uranium recovery, after 1964.

Gamma Emitting Fission and Activation Products

None detected in the 26 samples analyzed.

Technetium-99

Samples analyzed	6
Lowest measured U:Tc-99 ratio	0.51 ± 0.03

Discussion: Despite the fairly high absolute quantities of Tc-99 detected in samples from K-1420, the U:Tc-99 ratios are such that uranium would be the dominant hazard in all samples for all purposes. This is somewhat unexpected, in view of the process history of the building, which formerly handled equipment from all over the Site (including those high in Tc-99). Perhaps this result is due to dilution of high-Tc materials from selected areas of the Site with much greater quantities of low-Tc materials from most of the Site.

Transuranics

Samples analyzed	14
Lowest measured U:TRU ratio	43.2 ± 3.2
Highest measured U:TRU ratio	33800 ± 2400
Mean U:TRU ratio	2970
Samples with ratio < 500	8 of 14

Discussion: The samples from K-1420 consistently exhibit some of the lowest U:TRU ratios on the entire Site. Given the Decontamination Building's role in servicing equipment from throughout the Site, it is not surprising that there should be at least pockets where the contamination is relatively high in TRU. However, it is not clear why pockets of relatively high Tc-99 should not also be found.

5.21 K-1435

Status: Active

History: TSCA incinerator

Gamma Emitting Fission and Activation Products

None detected in the four samples analyzed.

Technetium-99

Samples analyzed	4
Lowest measured U:Tc-99 ratio	10.6 ± 0.5

Discussion: Tc-99, while detectable above MDA in samples from this building, is completely negligible compared to uranium for all purposes.

Transuranics

Samples analyzed	4
Lowest measured U:TRU ratio	736 ± 83
Highest measured U:TRU ratio	1440 ± 120
Mean U:TRU ratio	1140
Samples with ratio < 500	0 of 4

Discussion: TRU, while detectable above MDA in samples from this facility, is completely negligible compared to uranium for all purposes.

6.0 CONCLUSIONS AND RECOMMENDATIONS

This report contains only one piece of the contamination characterization puzzle for the Site. Any complete assessment of non-uranium contamination at the Site must include data from Non-Destructive Assay (NDA), results from any samples collected in the future from process equipment internals, and all other relevant information. This is because each such source has its own strengths and weaknesses:

- Samples of exposed contamination are easy to take, and radiochemical analysis of them yields results on all nuclides of interest. But each analysis is expensive, and the samples cannot cover the large contaminated areas of the plant that are inside equipment.

- On the other hand, NDA is relatively rapid and inexpensive, and in principle can yield results for even sealed equipment (provided the walls are not too thick). However, photon analysis cannot produce meaningful data on U-234 or Tc-99, two nuclides of great importance at the Site.

Therefore, two steps are recommended for furthering the accumulation of contamination data, and for making it more broadly useful:

- An on-going program should be instituted, such that when currently-sealed process equipment is opened or removed, samples of its internal contamination are routinely obtained, screened, and (if acceptable) analyzed for U, TRU, and Tc-99. These results would, over time, greatly increase detailed knowledge of the magnitude and extent of non-uranium contamination at the Site.

- A comprehensive database or handbook should be created to include data from all sources of contamination assessment data, permitting users to obtain from one reference the most complete information available about each building or facility on the Site. This document or database should be maintained up to date with information accumulated in the on-going sampling and analysis program.

APPENDIX A

SAMPLE DESCRIPTIONS AND RADIOCHEMISTRY RESULTS

The tables in this Appendix are organized according to the building where the samples were collected, and contain all the useful U, TRU, and Tc-99 sample results accumulated in the three phases of this assessment. The following sections describe changes that were made between the laboratory reports and these tabulations, and discuss other matters related to interpreting the tables.

A.1. Discussion of Phase 1 Data

A.1.1. General

The following comments pertain to the presentation of Phase 1 data in the tables of this Appendix:

- For reasons discussed in the next sub-section, the tables contain only the radiochemistry-based results for uranium and transuranics. Because of their unreliability, the gamma spectroscopy-based results for actinides were not used.

- The gamma spectroscopy analysis of all 84 samples was completed. However, 9 of the 52 samples selected for alpha analysis were spoiled at various points in the radiochemical separation process. They therefore have incomplete alpha results, which show as samples that have descriptions but no U or TRU results.

- ORAU originally reported 2-sample-standard-deviation counting uncertainty in the activity (2s). For consistency and calculation simplicity these were all converted to the 1s values which are presented in the tables.

- The TRU results for most samples were much closer to the limits of detection than were the uranium results. ORAU's conventions for reporting these low-level values changed at times during the analysis, but the results are presented as follows:

    - ORAU reported some results as "$< x$", meaning that they did not detect alpha particles from the radionuclide at a statistically-significant level above the background in the applicable portion of the alpha spectrum. In this notation, x is ORAU's minimum detectable activity (MDA) in the sample: the activity equivalent of 4.66 standard deviations of the background count rate in the applicable region of the spectrum. Any MDA less than 0.1 pCi was reported as 0.1 pCi. To permit summing, these results were treated as A=MDA, 1s=MDA, and they are presented this way in the tabulations.

    - In other cases, the activity and its standard deviation were reported as measured, regardless of their relationship to the sample's MDA. However, because of the ORAU practice of reporting no alpha spectroscopy values to finer precision than 0.1 pCi, any activity or 2s value that was measured as less than 0.05 pCi was

reported as 0.0. This is the explanation for values tabulated as "0.1 ± 0.0," "0.0 ± 0.0," etc.

A.1.2. Evaluation of Actinide Gamma Spectroscopy Data

As discussed in the body of the report, ORAU performed a preliminary gamma ray spectroscopy analysis of each sample to determine its uranium and TRU isotopic content. The following logic was used to exclude these gamma spectroscopy-based uranium and TRU results from consideration, giving preference to the radiochemistry-based alpha spectroscopy results.

First, it was apparent that the gamma spectroscopy results and the alpha spectroscopy results were not consistent with each other. In many but not all uranium analyses (for example), the gamma data for a given sample were 2 to 6 times the alpha data for the sample; but in other cases, the alpha results were higher. In most cases there was poor agreement between the U-235/U-238 ratios measured by the two methods.

It was harder to compare the two methods for TRU radionuclides because few of the TRU gamma analyses produced detectable results. However, for the cases where parallel data were available (for example, samples S52 and S54), the two measurements were not consistent.

These facts are apparently the results of the difficulty of the gamma measurements. The difficulties include the following:

- U-238 must be assayed based on radiations from its short-lived immediate daughters. If the first daughter is used (24.1-day Th-234), the gamma ray measured is a complex peak at about 92.5 keV (5.3% total). If the next daughter is used (1.17-minute Pa-234m), the gamma ray measured is a low abundance peak at 1001 keV (0.6%). Neither measurement is very sensitive, and the applicability of the results to U-238 depends on assumptions about parent-daughter equilibrium.

- U-235 may be measured directly based on its lines at 144 keV or 184 keV. The higher-abundance peak at 184 keV is subject to background interference from Ra-226.

- Since they are naturally-occurring radionuclides, gamma ray peaks due to U-238 daughters and U-235 both contain a background as well as a sample component that may be difficult to separate accurately.

- Several of the radionuclides of interest (U-234, Pu-238, Pu-239, Pu-240) have no useful photon emissions, either of their own or from their short-lived immediate daughters. The U-234 content cannot be inferred with any accuracy from the U-235 and U-238 because the contamination of most interest in this study has been enriched,

irradiated, and re-enriched. There is certainly no way to correlate the Pu isotopes to the TRU radionuclides that can be measured by photon emissions.

- The gamma-emitting TRU radionuclides Np-237 and Am-241 produce significant peaks only between about 60 keV and 95 keV. This region of the spectrum is crowded with background gamma rays and X-rays, as well as with emissions from the Th-234, Pa-234m, and U-235 that may also be present in the sample.

- The large-area smears that were used to collect some of the surface contamination are not a standard geometry for counting. They must therefore be folded several layers thick to approximate a geometry for which the gamma spectrometers are calibrated, but the accuracy of this approximation is questionable.

These observations support the decision to discount the gamma ray analysis results of U and TRU for the purpose of characterizing the K-25 Site contamination. The analyses did serve a purpose in screening samples to identify those promising for radiochemical TRU analysis, but they could not be used to determine whether and where on the Site TRU contamination is significant compared to uranium. Therefore, only the alpha spectroscopy results are presented below for characterizing the extent of TRU contamination at the K-25 Site.

A.2. Discussion of Phase 2 Data

None of the problems discussed above in relation to the Phase 1 data applied to the Phase 2 results:

- All the Phase 2 U and TRU results come from radiochemistry and alpha spectroscopy.

- ORAU reported all the numerical results as a value and an uncertainty, without "less-than" reporting or other left-truncation practices. ORAU reported uncertainty as a 2s value, which has been divided by 2 to yield the 1s values in the tables below.

- Only one of the 44 samples submitted was lost in processing. However, screening criteria determined which analyses were performed on a given sample. Therefore, some Phase 2 samples are listed in the description sections of the tabulations below, but do not have one or more of the radiochemistry results.

A.3. Discussion of Phase 3 Data

Even fewer problems were encountered in analyzing the Phase 3 results:

- All the Phase 3 U and TRU results come from radiochemistry and alpha spectroscopy.

- Lockheed reported all the numerical results as a value and a 1s uncertainty, without "less-than" reporting or other left-truncation practices. The only exception was the Tc-99 results for samples 1-17, which Lockheed inadvertently omitted from its original report, and later presented associated with 2s uncertainties.

- None of the 32 samples submitted was lost in processing. All samples received all analyses: U, TRU, Tc, and gamma spectroscopy.

- Lockheed provided extensive QA and QC data that buttress the reliability of its reported results.

Building: K- 25W

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
93	123	2	Unit 312-3	
94	124	2	Unit 312-1	Glove
95	1105	2	Unit 306-7	
100	5	3	Unit 306	
101	6	3	Unit 306	
102	7	3	Unit 312	
103	8	3	Unit 312	

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
93	7.04E+002	8.00E+000	1.00E+000	3.79E+001	2.50E+000	4.10E+000	2.40E+001	1.60E+000	1.90E+000
94	7.47E+006	2.60E+004	8.80E+003	2.49E+005	6.50E+003	1.20E+004	2.00E+004	2.50E+003	7.10E+003
95	2.01E+005	3.60E+002	2.10E+002	6.02E+003	8.50E+001	1.90E+002	4.92E+002	3.20E+001	9.30E+001
100	8.19E+003	6.70E+002	3.90E+001	4.09E+002	6.30E+001	2.70E+001	3.33E+003	3.00E+002	3.30E+001
101	1.12E+005	4.90E+003	1.40E+002	3.94E+003	3.90E+002	9.40E+001	1.50E+003	2.30E+002	1.50E+002
102	7.80E+005	3.40E+004	1.10E+003	3.71E+004	3.50E+003	1.10E+003	1.24E+004	1.90E+003	9.70E+002
103	1.25E+003	9.00E+001	9.80E+000	8.60E+001	1.50E+001	9.80E+000	2.67E+003	1.70E+002	8.00E+000

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
93	1.70E-001	5.00E-002	1.10E-001	1.22E+001	9.40E-001	5.90E-001
94	6.15E+002	8.90E+000	3.10E+000	1.92E+002	1.50E+001	3.30E+001
95	2.00E-002	2.00E-002	8.00E-002	3.01E+000	1.70E-001	3.20E-001
100	1.91E-001	5.70E-002	4.70E-002	9.30E+000	1.30E+000	8.60E-001
101	1.69E-001	6.60E-002	1.70E-001	7.08E+001	2.40E+000	4.60E-001
102	1.59E+001	6.10E-001	4.80E-002	9.81E+002	7.10E+000	7.10E-001
103	1.61E-001	6.20E-002	1.50E-001	3.49E+000	4.00E-001	5.30E-001

... building continued ...

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
93	2.00E-002	2.50E-002	7.00E-002	3.00E-002	2.00E-002	6.00E-002
94	3.48E+003	7.20E+001	4.50E+001	2.55E+003	6.10E+001	2.50E+001
95	1.30E-001	3.50E-002	8.00E-002	1.60E-001	3.50E-002	6.00E-002
100	5.90E-002	4.30E-002	1.50E-001	1.78E-001	5.80E-002	5.40E-002
101	-3.10E-002	6.80E-002	3.30E-001	9.40E-002	5.30E-002	8.40E-002
102	3.93E+001	1.50E+000	2.60E-001	7.83E+001	2.50E+000	7.60E-002
103	1.29E-001	4.50E-002	4.40E-002	1.77E-001	5.20E-002	4.40E-002

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
94	7.74E+006	2.70E+004	1.35E+002	4.20E+000	5.00E+000	5.73E+004	1.80E+003
100	1.19E+004	7.40E+002	4.94E+001	4.20E+000	9.50E+000	2.41E+002	2.50E+001
101	1.17E+005	4.90E+003	2.03E+001	3.50E+000	9.80E+000	5.79E+003	1.00E+003
102	8.29E+005	3.40E+004	2.69E+002	8.00E+000	1.00E+001	3.08E+003	1.60E+002
103	4.01E+003	1.90E+002	2.30E+001	6.20E+000	8.70E+000	1.74E+002	4.80E+001

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
93	7.66E+002	8.50E+000	1.24E+001	9.50E-001	6.17E+001	4.80E+000
94	7.74E+006	2.70E+004	6.84E+003	9.60E+001	1.13E+003	1.60E+001
95	2.08E+005	3.70E+002	3.32E+000	1.80E-001	6.25E+004	3.40E+003
100	1.19E+004	7.40E+002	9.73E+000	1.30E+000	1.23E+003	1.80E+002
101	1.17E+005	4.90E+003	7.10E+001	2.40E+000	1.65E+003	8.90E+001
102	8.29E+005	3.40E+004	1.11E+003	7.70E+000	7.44E+002	3.10E+001
103	4.01E+003	1.90E+002	3.96E+000	4.10E-001	1.01E+003	1.20E+002

Building: K- 27

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
84	14&15	2	Unit 402-8	Composite
85	1013	2	Unit 402-4	
86	1016	2	Unit 402-9	
87	9	3	Unit 402-2	
88	10	3	Unit 402-7	
89	11	3	Unit 402-8	
90	12	3	Unit 402-9	

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
84	3.11E+002	4.30E+000	8.00E-001	1.81E+001	1.30E+000	1.80E+000	3.64E+001	1.60E+000	1.20E+000
85	4.99E+002	4.40E+000	1.90E+000	2.51E+001	1.10E+000	1.40E+000	6.04E+001	1.60E+000	9.30E-001
87	3.34E+003	2.40E+002	1.90E+001	2.05E+002	2.90E+001	1.50E+001	4.31E+003	3.00E+002	1.70E+001
88	4.45E+004	2.10E+003	9.40E+001	1.99E+003	2.10E+002	5.60E+001	1.08E+004	6.40E+002	8.30E+001
89	1.61E+005	6.50E+003	1.10E+002	1.06E+004	6.70E+002	1.20E+002	1.57E+004	8.90E+002	9.80E+001
90	9.82E+004	4.80E+003	1.60E+002	5.29E+003	4.80E+002	1.40E+002	1.46E+004	9.50E+002	1.50E+002

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
84	8.00E-002	4.50E-002	1.20E-001	2.30E-001	1.20E-001	3.60E-001
85	1.80E-001	6.50E-002	1.70E-001	4.90E-001	9.50E-002	1.50E-001
87	4.29E-001	9.20E-002	5.50E-002	5.30E-001	1.50E-001	2.10E-001
88	1.31E-001	6.10E-002	1.70E-001	5.90E-001	5.00E-001	5.00E-001
89	1.65E-001	5.60E-002	1.20E-001	1.98E+002	5.40E+000	9.40E-001
90	6.70E-002	4.60E-002	1.60E-001	2.65E+001	1.10E+000	5.00E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
84	1.00E-002	1.00E-002	3.00E-002	1.00E-002	1.50E-002	4.00E-002
85	4.00E-001	6.50E-001	2.90E+000	4.00E-001	6.50E-001	2.90E+000
87	6.20E-002	5.30E-002	1.90E-001	8.40E-001	1.30E-001	1.50E-001
88	5.60E-001	1.30E-001	2.20E-001	8.80E-002	5.00E-002	7.90E-002
89	-4.70E-002	6.60E-002	3.10E-001	1.20E-001	5.30E-002	6.50E-002
90	-4.50E-002	4.40E-002	2.40E-001	7.00E-001	1.30E-001	1.70E-001

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
85	5.84E+002	4.80E+000	4.00E+004	3.90E+002	4.50E+001	1.46E-002	1.90E-004
87	7.86E+003	3.90E+002	3.04E+002	8.00E+000	9.30E+000	2.58E+001	1.40E+000
88	5.73E+004	2.20E+003	4.56E+003	3.00E+001	8.70E+000	1.26E+001	4.90E-001
89	1.87E+005	6.60E+003	1.78E+004	6.50E+001	1.20E+001	1.05E+001	3.70E-001
90	1.18E+005	4.90E+003	2.31E+005	2.90E+002	1.70E+001	5.10E-001	2.10E-002

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
84	3.66E+002	4.80E+000	3.30E-001	1.30E-001	1.11E+003	4.50E+002
85	5.84E+002	4.80E+000	1.47E+000	9.30E-001	3.98E+002	2.50E+002
87	7.86E+003	3.90E+002	1.86E+000	2.30E-001	4.22E+003	5.50E+002
88	5.73E+004	2.20E+003	1.37E+000	5.20E-001	4.18E+004	1.60E+004
89	1.87E+005	6.60E+003	1.98E+002	5.40E+000	9.45E+002	4.20E+001
90	1.18E+005	4.90E+003	2.72E+001	1.10E+000	4.34E+003	2.50E+002

Building: K- 29

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
73	JK-11	1	Near K-17 (402-4)	Duct wall
74	JK-20	1	Near J-2 (402-1)	Duct floor
75	JK-29	1	Near J-2 (402-1)	Duct wall
76	18	2	Unit 502-3	
77	19	2	Unit 502-3	
78	20	2	Unit 502-2	
79	21	2	Unit 502-2	
80	22	2	Unit 502-1	
81	23	2	Unit 502-1	
82	1020	2	Unit 502-2	
83	1023	2	Unit 502-1	

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
73	8.29E+001	1.20E+000		5.10E+000	5.00E-001		2.77E+001	7.00E-001	
74	8.75E+001	1.40E+000		4.60E+000	4.00E-001		5.37E+001	1.10E+000	
75	1.09E+002	1.50E+000		5.70E+000	4.50E-001		5.92E+001	1.10E+000	
76	2.51E+003	7.00E+001	3.70E+001	5.50E+001	1.80E+001	4.70E+001	1.29E+003	5.00E+001	2.90E+001
77	7.25E+003	7.00E+001	1.60E+001	5.20E+002	2.10E+001	1.80E+001	1.52E+003	3.20E+001	1.40E+001
78	1.65E+002	1.60E+000	3.00E-001	9.30E+000	4.50E-001	7.00E-001	3.33E+001	7.00E-001	2.00E-001
79	1.18E+003	1.90E+001	6.60E+000	5.90E+001	5.00E+000	6.30E+000	5.83E+002	1.30E+001	4.80E+000
80	2.59E+001	4.50E-001	1.00E-001	1.40E+000	1.50E-001	2.00E-001	6.60E+000	2.50E-001	2.00E-001
81	7.13E+002	5.00E+000	2.00E+000	3.03E+001	1.30E+000	1.90E+000	1.84E+002	2.50E+000	1.00E+000
82	4.53E+002	4.70E+000	1.30E+000	2.20E+001	1.30E+000	2.20E+000	9.84E+001	2.20E+000	1.10E+000
83	2.96E+003	1.40E+001	8.60E+000	1.24E+002	4.30E+000	9.70E+000	6.74E+002	7.00E+000	4.30E+000

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
73	3.00E-001	5.00E-002		1.00E-001	1.00E-001	1.00E-001
74	2.00E-001	5.00E-002		2.00E-001	2.00E-001	2.00E-001
75	4.00E-001	1.00E-001		2.00E-001	2.00E-001	2.00E-001
76	3.99E+000	2.80E-001	3.10E-001	9.00E-002	5.50E-001	1.80E+000

77	3.90E-001	7.50E-002	1.60E-001	3.40E-001	1.00E-001	2.10E-001
78	2.00E-002	3.00E-002	1.00E-001	2.00E-002	2.50E-002	6.00E-002
79	1.20E-001	1.00E-001	3.10E-001	3.00E-002	4.50E-002	1.20E-001
80	3.00E-002	2.00E-002	6.00E-002	1.00E-002	2.50E-002	7.00E-002
81	8.00E-002	4.50E-002	1.40E-001	7.00E-002	4.00E-002	9.00E-002
83	1.50E-001	3.50E-002	8.00E-002	2.30E-001	4.50E-002	8.00E-002

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
73	4.00E-001	1.00E-001		0.00E+000	5.00E-002	
74	2.00E-001	5.00E-002		0.00E+000	5.00E-002	
75	5.00E-001	1.00E-001		0.00E+000	5.00E-002	
76	1.00E-002	7.00E-002	2.40E-001	3.00E-002	5.00E-002	1.60E-001
77	1.00E-002	4.50E-002	1.50E-001	1.00E-002	5.50E-002	1.80E-001
78	1.00E-002	5.00E-003	2.00E-002	1.00E-002	5.00E-003	1.00E-002
79	3.00E-002	7.50E-002	2.50E-001	8.00E-002	4.50E-002	1.00E-001
80	0.00E+000	1.00E-002	4.00E-002	1.00E-002	1.00E-002	3.00E-002
81	1.00E-002	1.00E-002	3.00E-002	1.00E-002	1.00E-002	3.00E-002
83	5.70E-001	3.00E-001	9.50E-001	1.30E-001	1.20E-001	4.50E-001

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
77	9.29E+003	8.00E+001	3.07E+003	2.40E+001	1.10E+001	3.03E+000	3.50E-002
79	1.82E+003	2.40E+001	1.33E+004	3.50E+001	5.80E+000	1.37E-001	1.80E-003
82	5.73E+002	5.30E+000	2.22E+005	2.20E+003	1.50E+002	2.58E-003	3.50E-005

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
73	1.16E+002	1.50E+000	8.00E-001	1.60E-001	1.45E+002	2.90E+001
74	1.46E+002	1.80E+000	6.00E-001	2.20E-001	2.43E+002	8.80E+001
75	1.74E+002	1.90E+000	1.10E+000	2.50E-001	1.58E+002	3.60E+001
76	3.86E+003	8.80E+001	4.12E+000	6.20E-001	9.36E+002	1.40E+002
77	9.29E+003	8.00E+001	7.50E-001	1.40E-001	1.24E+004	2.40E+003
78	2.08E+002	1.80E+000	6.00E-002	4.00E-002	3.46E+003	2.30E+003
79	1.82E+003	2.40E+001	2.60E-001	1.40E-001	7.01E+003	3.80E+003
80	3.39E+001	5.40E-001	5.00E-002	3.50E-002	6.78E+002	4.70E+002
81	9.27E+002	5.80E+000	1.70E-001	6.20E-002	5.45E+003	2.00E+003
83	3.76E+003	1.70E+001	1.08E+000	3.30E-001	3.48E+003	1.10E+003

Building: K- 31

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
62	JK-37	1	Near DD-42 (602-1)	Duct floor
63	JK-46	1	Near DD-42 (602-1)	Duct wall
64	JK-55	1	Near X-49 (602-1)	Duct floor
65	JK-64	1	Near X-49 (602-1)	Duct wall
66	24	2	Unit 602-6	
67	25	2	Unit 602-5	
68	26	2	Unit 602-4	
69	30	2		Seal Exhaust
70	1028	2	Unit 602-2	
71	1029	2	Unit 602-1	
72	1031	2		Wet Air Pump

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
62	5.21E+001	1.40E+001		3.60E+000	5.00E-001		9.62E+001	1.90E+000	
63	4.67E+001	1.20E+000		2.20E+000	3.50E-001		1.23E+002	2.00E+000	
64	7.44E+001	1.80E+000		4.40E+000	5.50E-001		1.34E+002	2.30E+000	
65	6.54E+001	1.40E+000		3.60E+000	4.00E-001		8.80E+001	1.60E+000	
66	3.86E+002	1.20E+001	4.00E+000	2.13E+001	3.40E+000	3.90E+000	8.80E+001	5.50E+000	2.50E+000
67	3.42E+003	4.30E+001	3.60E+001	2.18E+002	1.60E+001	3.70E+001	3.54E+002	1.60E+001	3.60E+001
68	2.84E+003	4.40E+001	1.40E+001	1.44E+002	1.20E+001	1.60E+001	1.13E+003	2.80E+001	8.10E+000
69	1.17E+003	2.00E+001	3.80E+000	4.80E+001	5.50E+000	9.80E+000	6.28E+002	1.50E+001	5.40E+000
70	9.86E+002	1.20E+001	5.10E+000	6.27E+001	3.50E+000	4.60E+000	4.47E+002	8.00E+000	3.10E+000
72	1.48E+004	2.10E+002	7.70E+001	7.40E+002	6.00E+001	1.10E+002	9.10E+003	1.70E+002	9.90E+001

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
62	2.00E-001	5.00E-002		2.00E-001	2.00E-001	2.00E-001
63	2.00E-001	5.00E-002		2.00E-001	2.00E-001	2.00E-001
64	2.00E-001	5.00E-002		1.00E-001	1.00E-001	1.00E-001
65	1.00E-001	5.00E-002		1.00E-001	1.00E-001	1.00E-001
66	1.10E-001	6.00E-002	1.60E-001	2.00E-002	4.00E-002	1.10E-001

67	9.00E-002	5.00E-002	1.50E-001	4.40E-001	1.80E-001	4.10E-001
68	3.00E-002	8.50E-002	2.80E-001	0.00E+000	1.50E-002	5.00E-002
69	2.10E-001	4.00E-002	8.00E-002	4.00E-002	1.60E-001	5.20E-001
70	2.40E-001	6.00E-002	1.30E-001	4.40E-001	7.00E-002	1.20E-001
72	1.80E-001	6.00E-002	1.60E-001	2.10E-001	6.00E-002	1.30E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
62	5.00E-001	1.00E-001		0.00E+000	5.00E-002	
63	0.00E+000	5.00E-002		1.00E-001	5.00E-002	
64	0.00E+000	5.00E-002		1.00E-001	5.00E-002	
65	1.00E-001	1.00E-001	1.00E-001	1.00E-001	1.00E-001	1.00E-001
66	2.00E-002	3.50E-002	1.10E-001	2.00E-002	4.50E-002	1.30E-001
67	1.00E-002	1.50E-002	4.00E-002	1.00E-002	2.50E-002	8.00E-002
68	2.00E-002	4.00E-002	1.00E-001	2.00E-002	4.00E-002	1.00E-001
69	1.00E-002	2.00E-002	6.00E-002	1.00E-002	1.50E-002	5.00E-002
70	8.00E-002	5.00E-002	1.70E-001	3.00E-001	7.50E-002	1.80E-001
72	3.00E-002	4.00E-002	1.50E-001	2.00E-002	3.00E-002	1.20E-001

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
66	4.95E+002	1.40E+001	6.07E+002	7.00E+000	5.00E+000	8.16E-001	2.40E-002
68	4.11E+003	5.40E+001	1.93E+001	2.20E+000	5.90E+000	2.13E+002	2.40E+001
70	1.50E+003	1.40E+001	2.60E+003	2.60E+001	1.10E+001	5.75E-001	8.00E-003
72	2.46E+004	2.70E+002	1.62E+003	1.60E+001	7.00E+000	1.52E+001	2.20E-001

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
62	1.52E+002	1.40E+001	9.00E-001	2.30E-001	1.69E+002	4.70E+001
63	1.72E+002	2.40E+000	5.00E-001	2.20E-001	3.44E+002	1.50E+002
64	2.13E+002	2.90E+000	4.00E-001	1.30E-001	5.32E+002	1.80E+002
65	1.57E+002	2.20E+000	4.00E-001	1.80E-001	3.92E+002	1.80E+002
66	4.95E+002	1.40E+001	1.70E-001	9.20E-002	2.91E+003	1.60E+003
67	3.99E+003	4.90E+001	5.50E-001	1.90E-001	7.26E+003	2.60E+003
68	4.11E+003	5.40E+001	7.00E-002	1.00E-001	5.88E+004	8.70E+004
69	1.85E+003	2.60E+001	2.70E-001	1.70E-001	6.84E+003	4.20E+003
70	1.50E+003	1.40E+001	1.06E+000	1.30E-001	1.41E+003	1.70E+002
72	2.46E+004	2.70E+002	4.40E-001	9.80E-002	5.60E+004	1.30E+004

Building: K- 33

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
43	HV1	1	Samp Valve Sta	Air
44	JK-90	1	Near JA-15 (902-2)	Duct floor
45	S01	1	Unit 902-8	Thermal probe
46	S02	1	Feed Vapzn Rm	Floor
47	53	2	Unit 902-2	Valve
48	54	2		Seal Exhaust
49	55	2	Unit 902-3	
50	59	2	Unit 902-5	
51	61	2	Unit 902-7	
52	62	2	Unit 902-8	Floor
53	63	2	Unit 902-1	Cell Floor
54	1036	2		Wet Air Pump
55	1056	2	Unit 902-1	
56	13	3	Unit 902-5	
57	14	3	Unit 902-6	
58	15	3	Feed Vaporization	
59	16	3	Feed Vaporization	
60	17	3	Unit 902-7	
61	18	3	Unit 902-8	

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
43	2.35E+002	1.00E+001		1.16E+001	3.80E+000		5.49E+002	1.50E+001	
44	5.83E+001	1.30E+000		3.60E+000	4.00E-001		6.69E+001	1.40E+000	
45	5.86E+003	2.20E+002		4.20E+002	8.50E+001		4.06E+003	1.90E+002	
46	9.18E+002	2.80E+001		3.80E+001	7.00E+000		9.04E+002	3.10E+001	
47	4.72E+002	5.00E+000	2.10E+000	2.53E+001	1.40E+000	2.00E+000	2.80E+000	4.50E-001	8.00E-001
48	2.53E+002	6.00E+000	2.90E+000	1.13E+001	1.60E+000	2.70E+000	7.10E+001	3.40E+000	2.20E+000
50	3.54E+002	1.30E+001	6.60E+000	1.29E+001	4.00E+000	9.50E+000	3.33E+002	1.30E+001	1.00E+001
51	1.20E+003	3.20E+001	1.70E+001	7.40E+001	1.10E+001	2.20E+001	1.01E+003	2.90E+001	1.40E+001
53	1.67E+002	5.50E+000	3.40E+000	8.60E+000	1.80E+000	3.40E+000	2.51E+002	7.00E+000	3.00E+000
54	5.49E+003	1.00E+002	1.40E+002	5.00E+002	6.00E+001	1.80E+002	5.10E+003	1.00E+002	1.70E+002
55	5.87E+003	9.00E+001	4.50E+001	3.06E+002	2.70E+001	5.20E+001	4.12E+003	7.50E+001	4.30E+001
56	1.49E+003	1.00E+002	5.20E+000	7.90E+001	1.10E+001	4.50E+000	1.40E+003	9.60E+001	4.90E+000
57	2.08E+003	1.30E+002	8.20E+000	1.27E+002	1.60E+001	6.20E+000	1.75E+003	1.10E+002	6.90E+000
58	8.08E+003	8.40E+002	1.60E+001	5.56E+002	5.10E+001	9.90E+000	2.89E+003	1.70E+002	1.30E+001
59	4.36E+003	2.10E+002	7.40E+000	2.51E+002	2.40E+001	5.00E+000	1.50E+003	8.50E+001	5.00E+000

60	1.69E+003	1.20E+002	5.30E+000	1.28E+002	1.60E+001	4.10E+000	1.72E+003	1.20E+002	5.80E+000
61	4.16E+003	3.30E+002	2.00E+001	1.93E+002	3.30E+001	1.80E+001	4.92E+003	3.90E+002	1.60E+001

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
43	1.00E-001	5.00E-002		1.00E-001	1.00E-001	1.00E-001
44	1.00E-001	5.00E-002		2.00E-001	2.00E-001	2.00E-001
45	5.50E+000	3.00E-001		8.50E+000	8.50E+000	8.50E+000
46	2.30E+000	2.00E-001		8.60E+000	8.60E+000	8.60E+000
47	1.00E-001	3.50E-002	8.00E-002	4.80E-001	9.50E-002	1.90E-001
48	1.00E-002	3.00E-002	1.00E-001	9.00E-002	4.50E-002	1.00E-001
50	1.00E-001	3.00E-002	6.00E-002	3.00E-002	7.00E-002	2.20E-001
51	1.70E-001	7.00E-002	1.50E-001	4.00E-002	1.40E-001	4.60E-001
53	2.00E-002	3.00E-002	1.00E-001	6.00E-002	6.50E-002	1.80E-001
54	3.00E-002	5.50E-002	2.10E-001	2.70E-001	8.50E-002	2.10E-001
55	3.30E-001	5.50E-002	1.00E-001	1.67E+000	1.40E-001	2.70E-001
56	4.60E-002	2.60E-002	4.20E-002	1.06E+000	2.80E-001	7.40E-001
57	3.50E-002	4.20E-002	1.60E-001	1.05E+000	1.80E-001	3.10E-001
58	2.11E-001	6.30E-002	5.20E-002	6.44E+000	5.00E-001	4.10E-001
59	1.67E-001	6.00E-002	1.40E-001	2.65E+000	3.60E-001	5.00E-001
60	2.10E-001	6.90E-002	1.60E-001	1.74E+000	2.70E-001	5.60E-001
61	1.64E-001	5.10E-002	4.40E-002	1.26E+000	5.10E-001	4.60E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
43	1.00E-001	1.00E-001	1.00E-001	1.00E-001	1.00E-001	1.00E-001
44	1.00E-001	1.00E-001	1.00E-001	1.00E-001	5.00E-002	
45	5.60E+000	2.50E-001		2.00E-001	5.00E-002	
46	2.20E+000	1.50E-001		1.00E+000	1.00E+000	1.00E+000
47	1.00E-002	1.50E-002	4.00E-002	3.00E-001	5.00E-002	7.00E-002
48	2.00E-002	4.50E-002	1.50E-001	2.00E-002	2.00E-002	5.00E-002
50	1.00E-002	2.00E-002	6.00E-002	1.00E-002	2.00E-002	6.00E-002
51	4.00E-002	6.00E-002	1.70E-001	6.00E-002	4.50E-002	1.00E-001
53	1.00E-002	2.00E-002	6.00E-002	1.00E-002	1.50E-002	4.00E-002
54	2.00E-002	3.50E-002	1.40E-001	3.00E-002	3.00E-002	1.10E-001
55	1.00E-002	1.00E-002	5.00E-002	4.00E-002	2.00E-002	5.00E-002
56	7.90E-002	3.90E-002	5.40E-002	2.19E-001	6.50E-002	5.40E-002
57	-4.50E-002	3.10E-002	2.10E-001	2.20E-002	3.80E-002	1.60E-001
58	9.00E-002	6.30E-002	2.10E-001	2.49E-001	7.40E-002	6.10E-002
59	4.70E-002	3.30E-002	6.40E-002	9.40E-002	4.60E-002	6.40E-002
60	-7.60E-002	5.50E-002	3.00E-001	7.60E-002	5.50E-002	1.90E-001
61	0.00E+000	3.50E-002	1.80E-001	7.50E-002	4.30E-002	6.80E-002

Tc-99 RESULTS and RATIOS

Rec	Total U (pCi) Activity	Total U (pCi) 1-sigma	Tc-99 (pCi) Activity	Tc-99 (pCi) 1-sigma	Tc-99 (pCi) Sample MDA	U:Tc-99 Ratio Ratio	U:Tc-99 Ratio 1-sigma
51	2.28E+003	4.40E+001	1.00E+001	1.40E+000	4.10E+000	2.28E+002	3.30E+001
54	1.11E+004	1.50E+002	1.63E+003	1.60E+001	7.00E+000	6.80E+000	1.20E-001
56	2.97E+003	1.40E+002	2.82E+002	8.50E+000	9.90E+000	1.05E+001	5.90E-001
57	3.96E+003	1.70E+002	9.10E+001	5.00E+000	9.50E+000	4.35E+001	3.00E+000
58	1.15E+004	8.60E+002	1.07E+003	1.50E+001	9.10E+000	1.08E+001	8.20E-001
59	6.11E+003	2.30E+002	3.81E+002	9.00E+000	9.10E+000	1.60E+001	7.10E-001
60	3.54E+003	1.70E+002	7.49E+001	4.80E+000	9.80E+000	4.72E+001	3.80E+000
61	9.27E+003	5.10E+002	5.31E+002	1.10E+001	9.40E+000	1.75E+001	1.00E+000

U:TRU RATIOS

Rec	Total U (pCi) Activity	Total U (pCi) 1-sigma	Total TRU (pCi) Activity	Total TRU (pCi) 1-sigma	U:TRU Ratio Ratio	U:TRU Ratio 1-sigma
43	7.96E+002	1.80E+001	4.00E-001	1.80E-001	1.99E+003	9.00E+002
44	1.29E+002	2.00E+000	5.00E-001	2.30E-001	2.58E+002	1.20E+002
45	1.03E+004	3.00E+002	1.98E+001	8.50E+000	5.22E+002	2.20E+002
46	1.86E+003	4.20E+001	1.41E+001	8.70E+000	1.32E+002	8.10E+001
47	5.00E+002	5.20E+000	8.90E-001	1.10E-001	5.62E+002	7.20E+001
48	3.35E+002	7.10E+000	1.40E-001	7.30E-002	2.40E+003	1.30E+003
50	7.00E+002	1.90E+001	1.50E-001	8.10E-002	4.67E+003	2.50E+003
51	2.28E+003	4.40E+001	3.10E-001	1.80E-001	7.37E+003	4.20E+003
53	4.27E+002	9.10E+000	1.00E-001	7.60E-002	4.27E+003	3.20E+003
54	1.11E+004	1.50E+002	3.50E-001	1.10E-001	3.17E+004	1.00E+004
55	1.03E+004	1.20E+002	2.05E+000	1.50E-001	5.02E+003	3.70E+002
56	2.97E+003	1.40E+002	1.40E+000	2.90E-001	2.11E+003	4.50E+002
57	3.96E+003	1.70E+002	1.06E+000	1.90E-001	3.73E+003	6.90E+002
58	1.15E+004	8.60E+002	6.99E+000	5.10E-001	1.65E+003	1.70E+002
59	6.11E+003	2.30E+002	2.96E+000	3.70E-001	2.07E+003	2.70E+002
60	3.54E+003	1.70E+002	1.95E+000	2.90E-001	1.81E+003	2.80E+002
61	9.27E+003	5.10E+002	1.50E+000	5.20E-001	6.19E+003	2.20E+003

Building: K- 413

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
40	34	2		System 2 UF6
41	35	2		Equipment
42	1035	2		

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
40	6.01E+002	1.20E+001	4.40E+000	2.23E+001	2.70E+000	3.30E+000	1.52E+002	6.00E+000	4.40E+000
41	2.32E+001	3.50E-001	1.00E-001	1.00E+000	1.00E-001	1.00E-001	6.10E+000	2.00E-001	1.00E-001
42	9.19E+003	1.20E+002	6.50E+001	3.23E+002	3.20E+001	7.10E+001	1.82E+003	5.50E+001	5.90E+001

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
40	1.50E-001	3.50E-002	6.00E-002	7.00E-002	5.50E-002	1.50E-001
41	1.00E-002	4.00E-002	1.20E-001	1.00E-002	2.50E-002	7.00E-002
42	1.40E-001	5.00E-002	1.40E-001	4.80E-001	1.00E-001	2.00E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
40	5.00E-002	4.00E-002	1.20E-001	2.00E-002	3.00E-002	9.00E-002
41	2.00E-002	2.00E-002	6.00E-002	1.00E-002	1.50E-002	4.00E-002
42	5.00E-002	3.50E-002	1.20E-001	1.00E-002	2.00E-002	8.00E-002

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
42	1.13E+004	1.40E+002	4.61E+003	4.60E+001	1.30E+001	2.46E+000	3.80E-002

... building continued ...

U:TRU RATIOS

Rec	Total U (pCi) Activity	1-sigma	Total TRU (pCi) Activity	1-sigma	U:TRU Ratio Ratio	1-sigma
40	7.75E+002	1.30E+001	2.90E-001	8.20E-002	2.67E+003	7.60E+002
41	3.03E+001	4.20E-001	5.00E-002	5.30E-002	6.06E+002	6.50E+002
42	1.13E+004	1.40E+002	6.80E-001	1.20E-001	1.67E+004	2.90E+003

Building: K- 631

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
37	120	2		SW Corner
38	19	3		
39	20	3		

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
37	4.73E+003	7.00E+001	2.40E+001	2.44E+002	2.00E+001	3.50E+001	1.86E+003	4.30E+001	2.30E+001
38	1.14E+004	5.90E+002	2.70E+001	8.30E+002	7.50E+001	2.00E+001	2.73E+003	1.70E+002	2.40E+001
39	3.83E+003	3.20E+002	2.80E+001	2.85E+002	4.50E+001	2.20E+001	6.38E+003	5.10E+002	2.30E+001

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
37	3.00E-001	4.50E-002	7.00E-002	1.10E-001	1.00E-001	2.80E-001
38	9.70E-002	4.50E-002	1.30E-001	2.22E+000	5.80E-001	2.20E-001
39	1.19E-001	4.60E-002	1.10E-001	1.36E+000	3.30E-001	5.60E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
37	2.00E-002	2.00E-002	7.00E-002	3.00E-002	2.00E-002	5.00E-002
38	-5.10E-002	2.90E-002	1.80E-001	3.50E-002	3.40E-002	1.30E-001
39	1.50E-002	3.90E-002	1.60E-001	1.98E-001	5.40E-002	4.10E-002

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
38	1.50E+004	6.20E+002	1.32E+002	5.80E+000	9.20E+000	1.13E+002	6.80E+000
39	1.05E+004	6.00E+002	7.75E+001	4.70E+000	9.10E+000	1.35E+002	1.10E+001

... building continued ...

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
37	6.83E+003	8.50E+001	4.60E-001	1.20E-001	1.49E+004	3.80E+003
38	1.50E+004	6.20E+002	2.30E+000	5.80E-001	6.50E+003	1.70E+003
39	1.05E+004	6.00E+002	1.69E+000	3.40E-001	6.20E+003	1.30E+003

Building: K-1004A

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
36	4	2	19	Hood

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
36	1.28E+003	3.40E+001	1.80E+001	4.80E+001	9.50E+000	1.90E+001	5.27E+002	2.20E+001	1.10E+001

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
36	3.20E-001	7.50E-002	1.90E-001	8.00E-002	1.20E-001	3.60E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
36	1.00E-002	4.00E-002	1.30E-001	6.00E-002	2.50E-002	5.00E-002

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
36	1.86E+003	4.20E+001	4.70E-001	1.50E-001	3.95E+003	1.20E+003

Building: K-1004C

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
34	2	2	C 204	Hood
35	3	2	C 204	Hood

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
34	2.45E+003	2.70E+001	1.10E+001	1.16E+002	7.50E+000	1.20E+001	1.44E+003	2.00E+001	8.00E+000
35	8.93E+002	8.50E+000	4.00E+000	3.74E+001	2.10E+000	2.70E+000	4.11E+002	6.00E+000	3.00E+000

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
34	9.00E-002	3.00E-002	8.00E-002	1.00E-002	3.00E-002	1.00E-001
35	5.70E-001	8.00E-002	1.30E-001	1.00E-002	1.50E-002	5.00E-002

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
34	0.00E+000	5.00E-003	1.00E-002	1.00E-002	1.00E-002	3.00E-002
35	0.00E+000	1.00E-002	3.00E-002	0.00E+000	1.00E-002	4.00E-002

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
34	4.01E+003	3.50E+001	1.10E-001	4.40E-002	3.64E+004	1.50E+004
35	1.34E+003	1.10E+001	5.80E-001	8.30E-002	2.31E+003	3.30E+002

Building: K-1004L

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
32	111	2		Pilot Plnt Cab
33	1110	2		

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
32	7.83E+002	1.10E+001	5.00E+000	4.36E+001	3.00E+000	3.60E+000	8.25E+002	1.10E+001	3.00E+000
33	5.99E+003	9.50E+001	1.10E+002	6.90E+002	5.50E+001	1.50E+002	5.77E+003	1.00E+002	1.60E+002

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
32	8.00E-002	3.00E-002	6.00E-002	1.10E-001	3.50E-002	6.00E-002
33	1.50E-001	7.50E-002	2.30E-001	1.90E-001	8.00E-002	2.20E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
32	1.40E-001	2.60E-001	7.90E-001	4.20E-001	2.10E-001	4.60E-001
33	2.00E-002	4.00E-002	1.60E-001	2.00E-002	4.00E-002	1.60E-001

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
33	1.24E+004	1.50E+002	7.60E+000	1.90E+000	5.90E+000	1.64E+003	4.10E+002

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
32	1.65E+003	1.60E+001	7.50E-001	3.40E-001	2.20E+003	9.90E+002
33	1.24E+004	1.50E+002	3.80E-001	1.20E-001	3.28E+004	1.10E+004

Building: K-1006D

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
31	125	2	C 107	

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
31	3.36E+002	8.50E+000	2.00E+000	2.61E+001	3.00E+000	4.30E+000	1.30E+003	1.70E+001	4.00E+000

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
31	2.00E-001	6.50E-002	1.40E-001	5.90E-001	1.00E-001	1.80E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
31	5.60E-001	1.50E-001	4.50E-001	1.27E+000	1.40E-001	1.00E-001

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
31	1.66E+003	1.90E+001	0.00E+000	1.40E+000	4.70E+000	+.+0E+001	+.+0E+001

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
31	1.66E+003	1.90E+001	2.62E+000	2.40E-001	6.34E+002	5.90E+001

Building: K-1037

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
30	113	2		Waste Grit

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
30	6.34E+001	2.00E+000	1.30E+000	5.20E+000	7.50E-001	1.20E+000	3.49E+002	4.70E+000	1.40E+000

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
30	1.20E-001	3.50E-002	8.00E-002	1.60E-001	4.00E-002	4.00E-002

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
30	1.00E-002	2.50E-002	7.00E-002	1.00E-002	1.50E-002	4.00E-002

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
30	4.18E+002	5.10E+000	3.00E-001	6.10E-002	1.39E+003	2.80E+002

Building: K-1066

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
29	S59	1	B Yard	Cylinder

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
29	2.47E+002	4.20E+000		1.35E+001	1.40E+000		4.92E+001	1.90E+000	

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
29	1.00E-001	1.00E-001	1.00E-001	3.00E-001	3.00E-001	3.00E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
29	1.00E-001	1.00E-001	1.00E-001	1.00E-001	1.00E-001	1.00E-001

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
29	3.10E+002	4.70E+000	6.00E-001	3.50E-001	5.16E+002	3.00E+002

Building: K-1098E

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
28	77	2		Steel Rod

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
28	9.90E+001	5.50E+000	5.60E+000	9.20E+000	2.20E+000	4.40E+000	7.16E+002	1.40E+001	3.40E+000

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
28	1.60E-001	7.00E-002	1.80E-001	4.00E-002	7.00E-002	2.00E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
28	3.00E-002	5.00E-002	1.50E-001	2.10E-001	8.00E-002	1.80E-001

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
28	8.24E+002	1.60E+001	6.80E+000	1.10E+000	4.20E+000	1.21E+002	1.90E+001

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
28	8.24E+002	1.60E+001	4.40E-001	1.40E-001	1.87E+003	5.80E+002

Building: K-1131

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
24	S10	1	Feed Bay	Valves
25	S11	1	Feed Bay	Floor
26	S12	1	Feed Bay	EVAC Header
27	121	2		Cylinder Strg

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
24	4.35E+002	6.50E+000		2.90E+001	2.10E+000		7.58E+002	8.50E+000	
25	1.15E+003	6.00E+001		7.50E+001	2.60E+001		1.24E+003	6.50E+001	
26	1.76E+002	7.50E+000		1.03E+001	2.30E+000		1.83E+002	8.00E+000	
27	1.40E+003	5.50E+001	1.10E+001	4.20E+001	1.60E+001	3.80E+001	1.43E+003	5.50E+001	2.60E+001

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
24	1.10E+000	1.50E-001		4.10E+000	1.90E+000	
25	1.80E+000	1.50E-001		5.80E+000	5.80E+000	5.80E+000
26	2.00E-001	5.00E-002		6.80E+000	6.80E+000	6.80E+000
27	2.60E-001	5.00E-002	7.00E-002	1.90E-001	7.50E-002	1.40E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
24	1.10E+000	1.00E-001		1.00E-001	5.00E-002	
25	3.60E+000	2.00E-001		1.00E-001	1.00E-001	1.00E-001
26	1.00E-001	1.00E-001	1.00E-001	1.00E-001	1.00E-001	1.00E-001
27	1.40E+000	1.40E-001	3.00E-001	1.58E+000	1.20E-001	9.00E-002

Tc-99 RESULTS and RATIOS

Rec	Total U (pCi) Activity	Total U (pCi) 1-sigma	Tc-99 (pCi) Activity	Tc-99 (pCi) 1-sigma	Tc-99 (pCi) Sample MDA	U:Tc-99 Ratio Ratio	U:Tc-99 Ratio 1-sigma
27	2.87E+003	7.90E+001	8.76E+001	4.00E+000	6.30E+000	3.28E+001	1.70E+000

U:TRU RATIOS

Rec	Total U (pCi) Activity	Total U (pCi) 1-sigma	Total TRU (pCi) Activity	Total TRU (pCi) 1-sigma	U:TRU Ratio Ratio	U:TRU Ratio 1-sigma
24	1.22E+003	1.10E+001	6.40E+000	2.00E+000	1.91E+002	5.80E+001
25	2.47E+003	9.20E+001	1.13E+001	5.80E+000	2.18E+002	1.10E+002
26	3.69E+002	1.10E+001	7.20E+000	6.80E+000	5.13E+001	4.80E+001
27	2.87E+003	7.90E+001	3.43E+000	2.10E-001	8.37E+002	5.70E+001

Building: K-1231

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
22	21	3		
23	22	3		

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
22	8.50E+002	6.90E+001	4.70E+000	4.81E+001	7.90E+000	3.00E+000	1.11E+003	8.80E+001	4.90E+000
23	1.15E+002	5.40E+000	2.90E-001	6.21E+000	7.40E-001	2.90E-001	3.08E+001	2.00E+000	2.90E-001

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
22	5.55E-001	9.70E-002	1.60E-001	1.43E+000	2.30E-001	3.50E-001
23	1.12E-001	3.90E-002	3.80E-002	9.00E-002	1.20E-001	4.40E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
22	4.00E-002	4.80E-002	1.90E-001	4.75E+000	3.20E-001	1.50E-001
23	0.00E+000	0.00E+000	5.10E-002	5.60E-002	3.20E-002	5.10E-002

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
22	2.01E+003	1.10E+002	3.87E+002	9.10E+000	9.10E+000	5.19E+000	3.10E-001
23	1.52E+002	5.80E+000	1.26E+004	4.70E+001	8.10E+000	1.21E-002	4.60E-004

U:TRU RATIOS

Rec	Total U (pCi) Activity	1-sigma	Total TRU (pCi) Activity	1-sigma	U:TRU Ratio Ratio	1-sigma
22	2.01E+003	1.10E+002	6.78E+000	4.10E-001	2.96E+002	2.40E+001
23	1.52E+002	5.80E+000	2.58E-001	1.30E-001	5.89E+002	3.00E+002

Building: K-1401

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
21	S14	1	Retubing Area	Floor

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
21	2.17E+002	2.10E+000		8.20E+000	7.50E-001		1.09E+002	1.60E+000	

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
21	1.00E-001	5.00E-002		7.00E-001	1.50E-001	

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
21	1.00E-001	1.00E-001	1.00E-001	1.00E-001	1.00E-001	1.00E-001

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
21	3.34E+002	2.70E+000	1.00E+000	2.10E-001	3.34E+002	7.10E+001

Building: K-1410

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
19	23	3		
20	24	3		

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
19	2.52E+003	3.20E+002	2.50E+001	3.18E+002	5.80E+001	2.20E+001	1.96E+004	2.30E+003	1.70E+001
20	6.52E+002	4.80E+001	3.10E+000	3.40E+001	5.40E+000	2.00E+000	8.51E+002	6.10E+001	2.90E+000

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
19	1.38E-001	5.10E-002	1.30E-001	1.48E+000	3.20E-001	4.50E-001
20	1.07E+000	1.30E-001	4.10E-002	2.08E+000	3.70E-001	1.80E-001

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
19	-7.30E-002	6.40E-002	3.20E-001	1.28E-001	7.40E-002	2.30E-001
20	8.20E-002	3.60E-002	4.40E-002	1.01E+001	4.50E-001	4.40E-002

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
19	2.24E+004	2.30E+003	9.92E+002	1.50E+001	9.50E+000	2.26E+001	2.40E+000
20	1.54E+003	7.80E+001	2.49E+002	7.40E+000	8.90E+000	6.17E+000	3.60E-001

... building continued ...

U:TRU RATIOS

Rec	Total U (pCi) Activity	1-sigma	Total TRU (pCi) Activity	1-sigma	U:TRU Ratio Ratio	1-sigma
19	2.24E+004	2.30E+003	1.67E+000	3.40E-001	1.34E+004	3.00E+003
20	1.54E+003	7.80E+001	1.33E+001	6.00E-001	1.15E+002	7.80E+000

Building: K-1420

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
5	S52	1	U-Recov, B Area	Centrifuge
6	S53	1	U-Recov, B Area	Drip Pan
7	S54	1	U-Recov, B Mez	Floor
8	S55	1	H-Area	Floor
9	S56	1	Ash Plvrzr Rm	Floor
10	114	2		Floor
11	115	2		Floor
12	116	2		Blender
13	117	2		Jacket Heater
14	119	2		Floor
15	29	3		
16	30	3		
17	31	3		
18	32	3		

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
5	1.31E+004	3.80E+002		9.50E+002	1.40E+002		4.88E+003	2.40E+002	
6	5.89E+000	1.50E+001		8.20E+001	7.50E+000		2.04E+002	9.50E+000	
7	1.40E+004	5.80E+002		4.70E+002	1.80E+002		1.01E+004	5.00E+002	
8	6.01E+002	1.80E+001		1.93E+002	1.20E+001		2.62E+002	1.20E+001	
9	1.68E+005	1.80E+003		8.91E+003	5.70E+002		5.35E+003	3.50E+002	
10	1.01E+003	1.00E+001	5.00E+000	5.75E+001	3.10E+000	4.90E+000	6.05E+002	8.00E+000	3.00E+000
11	2.67E+004	1.90E+002	8.70E+001	8.70E+002	6.00E+001	1.50E+002	9.73E+003	1.20E+002	5.00E+001
12	5.63E+003	4.60E+001	1.70E+001	2.63E+002	1.20E+001	1.30E+001	1.81E+002	8.00E+000	4.00E+000
13	2.64E+004	1.10E+002	6.30E+001	9.42E+002	2.60E+001	4.40E+001	1.45E+002	1.00E+001	2.10E+001
14	1.17E+003	8.00E+000	2.00E+000	4.62E+001	2.20E+000	4.50E+000	3.09E+002	4.20E+000	1.70E+000
15	3.76E+003	3.60E+002	8.80E+000	1.39E+002	3.40E+001	5.00E+000	1.19E+003	1.40E+002	7.10E+000
16	4.81E+003	4.00E+002	1.40E+001	2.89E+002	5.90E+001	1.10E+001	1.86E+003	1.90E+002	1.00E+001
17	7.34E+004	7.90E+003	2.10E+002	5.60E+003	1.10E+003	2.00E+002	2.83E+004	3.60E+003	2.00E+002
18	6.93E+004	6.30E+003	1.70E+002	3.21E+003	7.40E+002	1.50E+002	2.32E+004	2.60E+003	1.60E+002

TRU RESULTS

Rec	Am-241 (pCi) Activity	1-sigma	Sample MDA	Np-237 (pCi) Activity	1-sigma	Sample MDA
5	3.80E+000	2.50E-001		2.33E+001	1.00E+000	
6	6.00E-001	1.00E-001		2.50E+000	3.00E-001	
7	2.94E+001	7.00E-001		8.38E+001	1.60E+000	
8	3.00E-001	5.00E-002		2.00E-001	2.00E-001	2.00E-001
9	5.00E-001	1.00E-001		4.40E+000	3.50E-001	
10	3.10E-001	4.50E-002	6.00E-002	3.32E+000	3.80E-001	5.20E-001
11	1.23E+001	3.10E-001	1.70E-001	3.33E+001	7.50E+000	1.60E+001
12	7.50E-001	9.50E-002	1.50E-001	9.10E-001	2.00E-001	1.90E-001
13	2.20E+000	1.40E-001	2.20E-001	3.13E+001	1.10E+000	1.30E+000
14	1.90E-001	5.50E-002	9.00E-002	8.30E-001	1.20E-001	2.00E-001
15	6.30E-001	1.90E-001	3.80E-002	1.31E-001	3.30E-002	6.50E-001
16	2.66E+001	1.50E+000	3.80E-002	5.90E+000	2.00E-001	5.70E-001
17	2.02E+001	1.30E+000	3.90E-002	3.32E+000	1.50E-001	4.70E-001
18	7.94E+000	7.70E-001	1.90E-001	2.91E+000	1.60E-001	4.90E-001

Rec	Pu-238 (pCi) Activity	1-sigma	Sample MDA	Pu-239/240 (pCi) Activity	1-sigma	Sample MDA
5	9.00E-001	1.00E-001		1.87E+001	4.50E-001	
6	2.00E-001	5.00E-002		2.40E+000	1.50E-001	
7	1.21E+001	3.50E-001		2.16E+002	1.50E+000	
8	1.00E-001	1.00E-001	1.00E-001	2.00E-001	5.00E-002	
9	1.00E-001	1.00E-001	1.00E-001	4.00E-001	5.00E-002	
10	6.00E-002	2.00E-002	4.00E-002	3.06E+000	1.40E-001	1.00E-001
11	4.10E-001	1.10E-001	2.90E-001	3.45E+001	6.60E-001	2.80E-001
12	1.60E-001	5.00E-002	8.00E-002	1.63E+000	1.40E-001	2.00E-001
13	9.55E+000	2.40E-001	3.30E-001	3.65E+000	1.40E-001	9.00E-002
14	1.30E-001	5.50E-002	1.40E-001	3.10E-001	6.50E-002	9.00E-002
15	2.10E-001	1.40E-001	1.70E-001	3.65E+000	5.10E-001	1.20E-001
16	5.51E+000	5.60E-001	1.10E-001	1.23E+002	5.80E+000	1.10E-001
17	8.37E+000	7.90E-001	1.70E-001	1.95E+002	9.80E+000	1.30E-001
18	1.04E+001	8.40E-001	1.60E-001	3.62E+002	1.60E+001	1.20E-001

Tc-99 RESULTS and RATIOS

Rec	Total U (pCi) Activity	1-sigma	Tc-99 (pCi) Activity	1-sigma	Sample MDA	U:Tc-99 Ratio Ratio	1-sigma
11	3.73E+004	2.30E+002	1.70E+004	4.60E+001	5.00E+000	2.19E+000	1.50E-002
14	1.53E+003	9.30E+000	1.93E+003	1.40E+001	5.00E+000	7.90E-001	7.70E-003
15	5.09E+003	3.90E+002	1.18E+003	3.20E+001	9.40E+000	4.31E+000	3.50E-001
16	6.96E+003	4.50E+002	1.36E+004	1.10E+002	1.00E+001	5.12E-001	3.30E-002

17	1.07E+005	8.80E+003	3.09E+004	3.70E+002	5.00E+001	3.47E+000	2.90E-001
18	9.57E+004	6.90E+003	2.92E+004	3.60E+002	5.00E+001	3.28E+000	2.40E-001

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
5	1.89E+004	4.70E+002	4.67E+001	1.10E+000	4.05E+002	1.40E+001
6	2.92E+002	1.90E+001	5.70E+000	3.50E-001	5.12E+001	4.60E+000
7	2.46E+004	7.80E+002	3.41E+002	2.30E+000	7.20E+001	2.30E+000
8	1.06E+003	2.40E+001	8.00E-001	2.30E-001	1.32E+003	3.90E+002
9	1.82E+005	1.90E+003	5.40E+000	3.80E-001	3.38E+004	2.40E+003
10	1.67E+003	1.30E+001	6.75E+000	4.10E-001	2.48E+002	1.50E+001
11	3.73E+004	2.30E+002	8.05E+001	7.50E+000	4.63E+002	4.30E+001
12	6.07E+003	4.80E+001	3.45E+000	2.70E-001	1.76E+003	1.40E+002
13	2.75E+004	1.10E+002	4.67E+001	1.10E+000	5.89E+002	1.40E+001
14	1.53E+003	9.30E+000	1.46E+000	1.60E-001	1.04E+003	1.10E+002
15	5.09E+003	3.90E+002	4.62E+000	5.60E-001	1.10E+003	1.60E+002
16	6.96E+003	4.50E+002	1.61E+002	6.00E+000	4.32E+001	3.20E+000
17	1.07E+005	8.80E+003	2.27E+002	9.90E+000	4.73E+002	4.40E+001
18	9.57E+004	6.90E+003	3.83E+002	1.60E+001	2.50E+002	2.10E+001

Building: K-1435

SAMPLE DESCRIPTIONS

Rec	Samp#	Phase	Room	Object
1	25	3		
2	26	3		
3	27	3		
4	28	3		

URANIUM RESULTS

	U-234 (pCi)			U-235 (pCi)			U-238 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
1	5.31E+003	3.90E+002	2.40E+001	3.49E+002	5.10E+001	1.70E+001	6.84E+003	4.90E+002	2.50E+001
2	1.18E+004	7.40E+002	4.40E+001	7.70E+002	1.00E+002	3.40E+001	1.58E+004	9.50E+002	5.10E+001
3	8.40E+002	5.90E+001	4.40E+000	4.99E+001	7.60E+000	3.50E+000	8.80E+002	6.10E+001	3.80E+000
4	2.67E+002	1.70E+001	1.60E+000	1.13E+001	2.20E+000	1.60E+000	3.63E+002	2.30E+001	1.40E+000

TRU RESULTS

	Am-241 (pCi)			Np-237 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
1	5.10E-001	1.50E-001	3.60E-001	2.97E+000	4.90E-001	7.80E-001
2	8.70E-001	1.10E-001	4.10E-002	8.14E+000	7.60E-001	6.60E-001
3	2.75E-001	8.20E-002	1.80E-001	4.80E-001	1.20E-001	2.20E-001
4	1.50E-001	5.90E-002	1.60E-001	9.80E-002	5.60E-002	8.90E-002

	Pu-238 (pCi)			Pu-239/240 (pCi)		
Rec	Activity	1-sigma	Sample MDA	Activity	1-sigma	Sample MDA
1	1.63E+000	1.60E-001	1.60E-001	3.59E+000	2.40E-001	4.20E-002
2	2.50E+000	2.40E-001	1.30E-001	1.05E+001	5.30E-001	1.30E-001
3	7.90E-002	5.10E-002	1.50E-001	1.57E+000	1.90E-001	6.60E-002
4	3.70E-002	4.70E-002	1.80E-001	2.98E-001	9.30E-002	8.10E-002

... building continued ...

Tc-99 RESULTS and RATIOS

	Total U (pCi)		Tc-99 (pCi)			U:Tc-99 Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Sample MDA	Ratio	1-sigma
1	1.25E+004	6.30E+002	4.83E+002	1.40E+001	1.60E+001	2.59E+001	1.50E+000
2	2.84E+004	1.20E+003	2.68E+003	2.60E+001	1.20E+001	1.06E+001	4.60E-001
3	1.77E+003	8.50E+001	1.88E+001	3.10E+000	8.80E+000	9.41E+001	1.60E+001
4	6.41E+002	2.90E+001	5.12E+001	4.10E+000	9.20E+000	1.25E+001	1.10E+000

U:TRU RATIOS

	Total U (pCi)		Total TRU (pCi)		U:TRU Ratio	
Rec	Activity	1-sigma	Activity	1-sigma	Ratio	1-sigma
1	1.25E+004	6.30E+002	8.70E+000	5.90E-001	1.44E+003	1.20E+002
2	2.84E+004	1.20E+003	2.20E+001	9.60E-001	1.29E+003	7.90E+001
3	1.77E+003	8.50E+001	2.40E+000	2.40E-001	7.36E+002	8.30E+001
4	6.41E+002	2.90E+001	5.83E-001	1.30E-001	1.10E+003	2.50E+002

APPENDIX B

DESCRIPTION OF PAST PROCESS OPERATIONS

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B.1 PURPOSE

As it exists today, the K-25 Site includes over 160 buildings, and many acres of floor space. Sampling any substantial fraction of that area would not be feasible for a limited characterization study, and would not necessarily yield useful information: some of the buildings are new enough, or have such a history, that contamination (including non-uranium contamination) would not be expected. Therefore, the characterization effort has emphasized process, maintenance, and laboratory buildings.

The size and extent of even this subset of buildings prevent a comprehensive sampling program on a limited budget and schedule. Furthermore, because of contamination removal and fixation efforts, only a relatively small amount of area with removable contamination is exposed and available for sampling at a given time.

Given these constraints on the sampling program, the question arises: What is the magnitude of non-uranium contamination in the places that *were not* sampled? In general, this question cannot be answered with great confidence and precision. However, in the former process buildings, where the problem of un-sampled area is greatest (because of their size), knowledge of how the production process was arranged may help provide a framework on which to arrange — and from which to extrapolate — the results. For this reason, the assessment effort included attempts to assemble and collate such process history information.

The most comprehensive compilation of general process history information found during this assessment is in Chapter 4 of the document K/D-6052[4]. In addition, some experienced individuals were interviewed who offered undocumented anecdotal testimony. The information in this appendix comes from those sources, and is subject to revision if better-documented information is found.

Since the purpose of this historical survey was to organize the non-uranium contamination results, the effort to uncover historical information concentrated on the period when reactor returns were handled at the K-25 Site: approximately 1952-1977. The following notes apply throughout the discussion that follows:

- The site is called the Oak Ridge Gaseous Diffusion Plant (ORGDP), to distinguish it from the K-25 building.
- Unit numbers referenced in describing process flows are the nominal points where a given activity occurred. At any given time, a particular unit (and certainly a

4. D. A. Kucsmas and R. M. Tuft, *K-25 / K-27 Buildings Historical Characterization,* MMES Rept K/D-6052. September 1992.

particular cell within that unit) might be out of service. In such a case, the unit's function would be passed over to an adjacent unit.

- The schematic diagrams included below are based on those in K/D-6052, as augmented by the anecdotal evidence. Dates are approximate.

- Successive sections summarize briefly the changes from the previous period.

B.2 OUTLINE OF OPERATIONS

B.2.1 Initial Operations: 1945-1946

The K-25 Building enters operation, producing uranium of moderately high enrichment for finishing at Y-12. All feed is natural uranium. See Figure B-1.

Top Product: K-306-7
Bottom Unit: K-311-1
Tails Facility: K-601
Purge Units: K-312

B.2.2 Initial Expansion: 1946-1948

The K-27 Building enters operation, in an overlap mode with the bottom of the K-25 cascade. All feed is natural uranium. A new tails unit is established in K-631. See Figure B-2.

Top Product: K-306-7
Bottom Unit: K-402-1
Tails Facility: K-631
Purge Units: K-312

B.2.3 Configuration Changes: 1948-1951

The K-27 Building is placed in series operation with the K-25 cascade to produce the highest enrichment product then available. All feed is natural uranium. A dedicated feed unit is established in K-131. See Figure B-3.

Top Product: K-306-7
Bottom Unit: K-311-1
Feed Facility: K-131
Tails Facility: K-631
Purge Units: K-312

B.2.4 Increased Production: 1951-1952

The K-29 Building is placed in series operation with the existing cascade, serving as the near-natural enrichment section. This establishes the pattern of building ever larger and more efficient units for use at the high-flow near-natural part of the cascade, increasing the production rate of the highest enrichment product from smaller existing equipment at the top of the cascade. All feed is natural uranium. See Figure B-4.

Top Product: K-306-7
Bottom Unit: K-311-1
Feed Facility: K-131
Tails Facility: K-631
Purge Units: K-312

B.2.5 Reactor Returns Begin: 1952-1954

The K-31 Building is placed in series operation with the existing cascade, again serving as the near-natural enrichment section. For the first time, reactor returns from the AEC Hanford and Savannah River plants are fed at the ORGDP. K-311-1, formerly the bottom of the cascade, is converted to serve as a side purge. See Figure B-5.

Top Product: K-306-7
Bottom Unit: K-402-1
Feed Facility: K-131
Tails Facility: K-631
Purge Units: K-312, K-311-1

During 1952-1961, ORGDP operated an on-site fluorination plant at K-1131 for both returned and virgin feed material. In the years 1952-1954, this was the only fluorination plant in the Atomic Energy Commission (AEC) complex, but after about 1954 a second fluorination plant came on-line at the Paducah Gaseous Diffusion Plant (PGDP). When that occurred, ORGDP ceased feeding its fluorination product direct to its own cascade, as had been the practice to that time, and instead shipped the UF_6 to PGDP for preliminary enrichment.

[The fluorinated returns were fed at PGDP because after reactor burn-up, the uranium was below natural assay in U-235. In general, one would expect the TRU compounds (probably being heavier than $^{238}UF_6$) to concentrate at the feed and tails portions of the cascade. Since that portion of the process was at ORGDP only during 1952-1954, and at PGDP after 1954, one would expect PGDP to have a worse level of TRU contamination than does the K-25 Site. Available evidence indicates that this is the case.]

K-1131 received the returns in oxide form for fluorination. Ash from the fluorination process (i.e., the material which did not become volatile) was collected in ash receivers.

These ash receivers were emptied at K-1231, where recovery processes attempted to extract any residual uranium; this included an ash pulverizer at the west end of the building. K-1410 (but not K-1420, which was not yet in service) was used for decontaminating any equipment from K-1131 during this period.

Prior to 1954, the K-1131 fluorination product was fed directly to the cascade. After 1954, the returned UF_6, partially enriched at PGDP (to $< \sim 1\%$ in U-235), was vaporized and fed from K-131 into the appropriate point in the cascade. [The feed point would have been somewhere in K-33, depending on the exact assay of the partially-enriched material.] The contents of small and non-standard cylinders were vaporized and fed from the K-33 Feed Vaporization room. Unlike the K-1131 process, the K-33 feed vaporization process included TRU traps; apparently, the material in these traps was never analyzed, and the effectiveness of the traps is unknown today.

B.2.6 Maximum Operation Begins: 1954-1957

The final cascade building, K-33, is placed in series operation with the existing cascade, again serving as the near-natural enrichment section. The cascade flow is split open in the K-31 Building, so that its upper portion serves as slightly-enriched enriching units, and its lower portion as slightly-depleted stripping units. A coolant removal unit is added at K-101. Processing of returns continues, but the UF_6 product is now routed through the Paducah Gaseous Diffusion Plant before being fed at ORGDP. See Figure B-6.

Top Product: K-306-7
Bottom Unit: K-402-1
Feed Unit: K-131 and K-33 Feed Vaporization Room
Tails Facility: K-631
Purge Units: K-312, K-311-1

B.2.7 Configuration Changes: 1957-1959

With the shutdown of the ORGDP power house, equipment with special power requirements (including all of the K-306 section of K-25) is removed from service. Processing of returns through PGDP continues. See Figure B-7.

Top Product: K-305-12
Bottom Unit: K-402-1
Feed Unit: K-131 and K-33 Feed Vaporization Room
Tails Facility: K-631
Purge Units: K-312, K-311-1, K-310-3

B.2.8 Configuration Changes: 1959-1961

For power distribution reasons, the top three K-312 units are shut down. Otherwise, the process flow is unchanged. Processing of returns through PGDP continues. See Figure B-8.

Top Product: K-305-9
Bottom Unit: K-402-1
Feed Unit: K-131 and K-33 Feed Vaporization Room
Tails Facility: K-631
Purge Units: K-312, K-311-1, K-310-3

B.2.9 End of Fluorination: 1962-1964

About this time, ORGDP ceases fluorinating feed material when the AEC transfers most such functions to commercial facilities. At that time, the K-1131 fluorination facility is converted for feed vaporization and tails withdrawal, and the K-33 Feed Vaporization Room is shut down. K-631 is converted from being the Tails Unit to providing surge capacity at the bottom of the cascade. No reactor returns are processed during this period. See Figure B-9.

Top Product: K-305-9
Bottom Unit: K-402-1
Feed Facility: K-1131
Tails Facility: K-1131
Purge Units: K-312, K-311-1, K-310-3

B.2.10 Reduced Operation: 1964-1977

In 1964, most of the K-25 and K-27 buildings are shut down permanently, and the production of highly-enriched uranium at the ORGDP ceases. The operation of the remainder of the cascade is affected accordingly. K-311-1 becomes the top purge of the shortened cascade, and a new product withdrawal facility is added at K-413. Final campaigns of reactor returns processing, including material from foreign reactors and domestic commercial reactors, occur in 1969-1974 and 1976-1977. See Figure B-10.

Top Product: K-502-3
Bottom Unit: K-602-1
Feed Facility: K-1131
Tails Facility: K-1131
Purge Units: K-311-1, K-310-3

During this period, K-1420 enters service as the Decontamination and Uranium Recovery Facility for the entire Site, and K-1231 and K-1410 are shut down. Acid cleaning in

K-1420 removed uranium residues from equipment to be repaired or maintained. An extraction and calcining process concentrated the uranium to a black oxide, which was then fluorinated for return to the cascade.

B.2.11 Final Years: 1977-1985

The last portion of the K-25 building is shut down as K-27 units are converted to be the top purge. All feed during these years is natural. In June of 1985, the entire ORGDP cascade is shut down. See Figure B-11.

Top Product: K-502-3
Bottom Unit: K-602-1
Feed Facility: K-1131
Tails Facility: K-1131
Purge Units: K-402-8 and -9

B.3 MIXING OF PROCESS EQUIPMENT

Interviewees indicated that very little mixing of equipment from point to point in the cascade occurred during the operational period. Some small parts, such as mechanical seals, could be interchanged relatively freely after reconditioning. However, because of differences in equipment sizes, compressors and converters could not be used outside their original buildings. In fact, because of special modifications, large equipment often could not be moved between units, and in some cases could not be moved between cells.

Certain facilities did serve the entire site, and would be contaminated with mixed material from all parts of the enrichment process. This would include maintenance and decontamination facilities (e.g., K-1401, K-1410, K-1420). Even within one cascade building, some equipment (such as the Wet Air Pump and its associated seal exhaust, and the building ventilation system) served more than one unit, and could be contaminated with mixed material from throughout the building.

With the exceptions cited in the preceding paragraph, contamination at a given point in the process buildings generally should be representative of a specific point in the enrichment process, with minimal influence of materials from other points in the process.

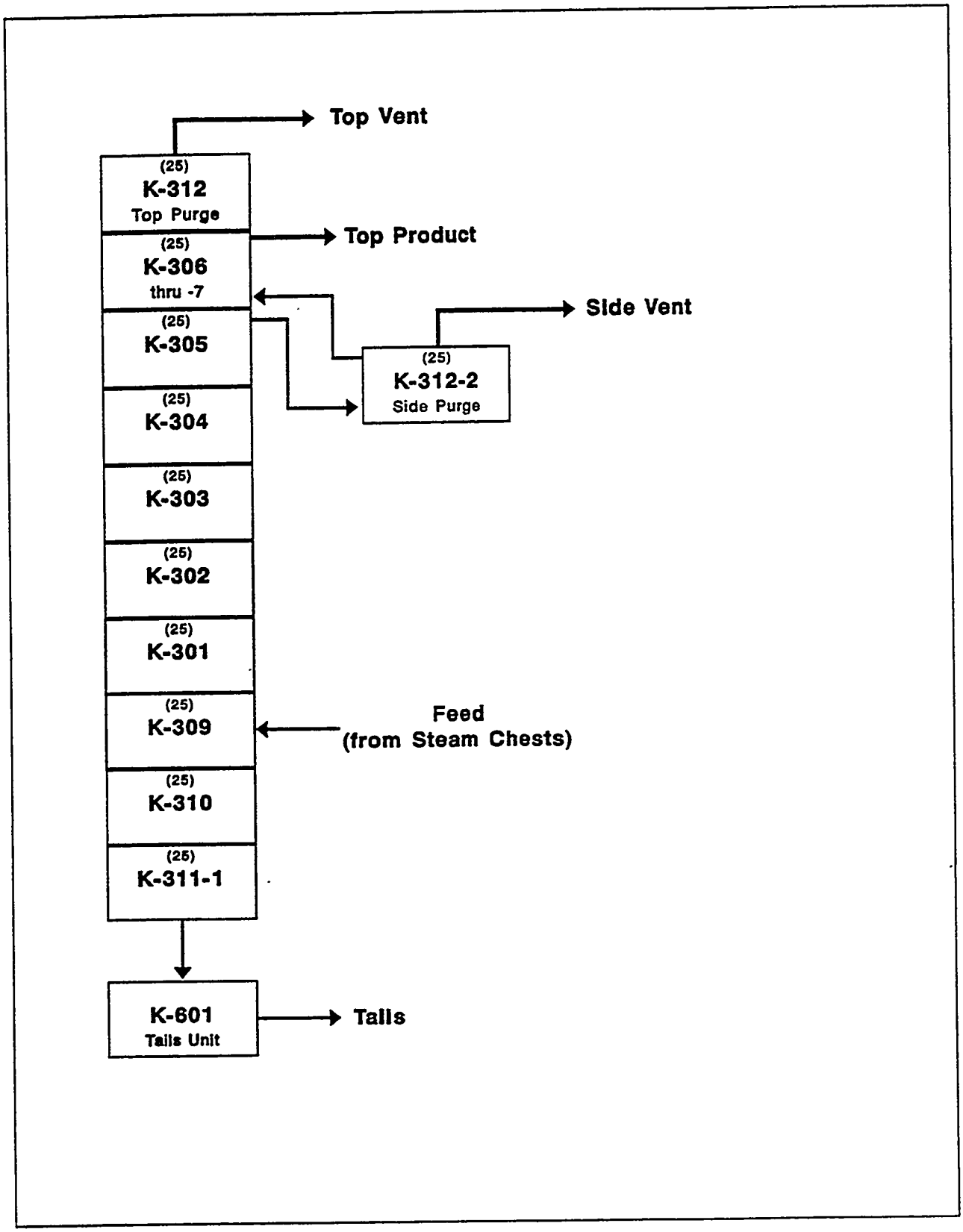

Figure B-1. Schematic Process Flow, 1945-1946

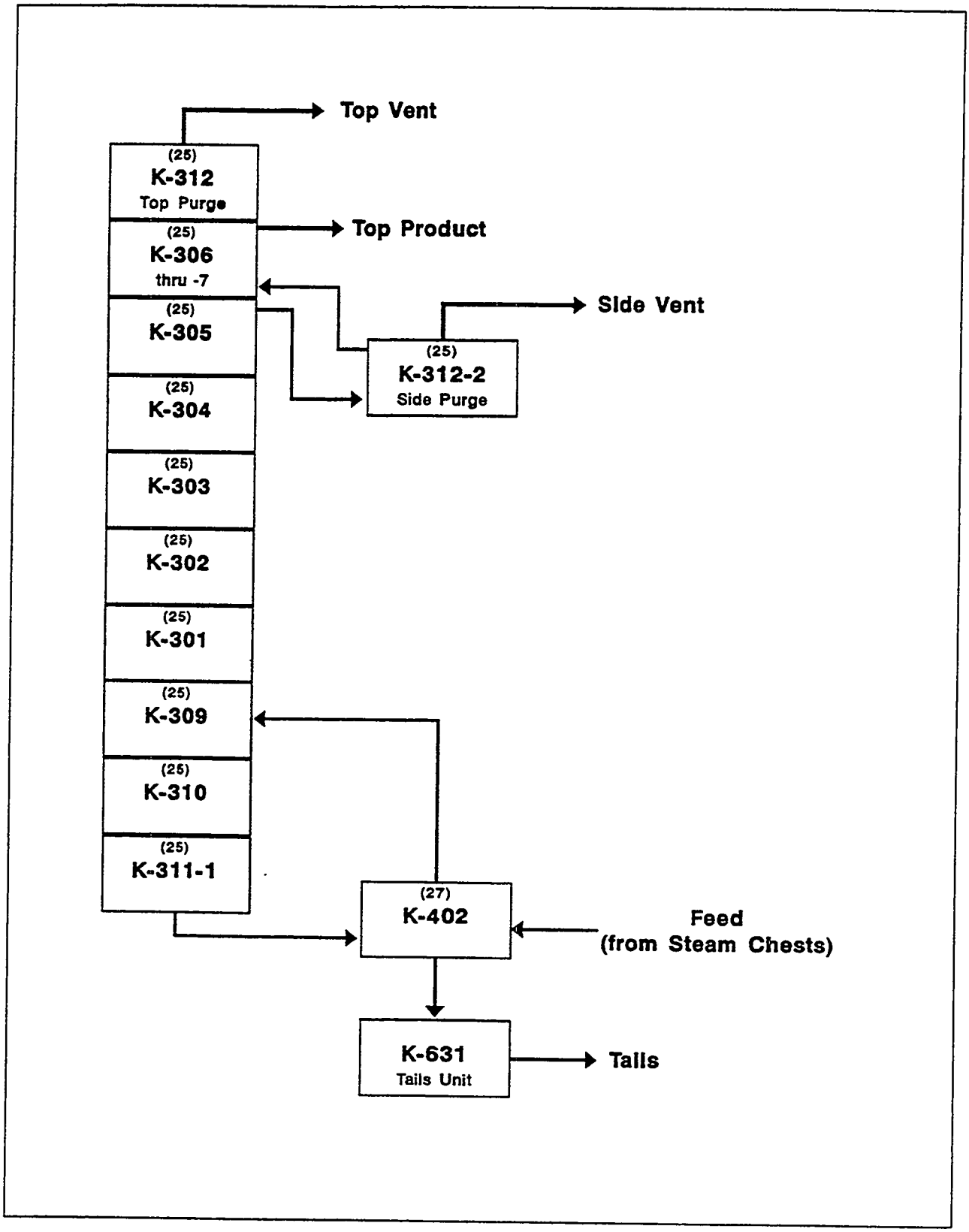

Figure B-2. Schematic Process Flow, 1946-1948

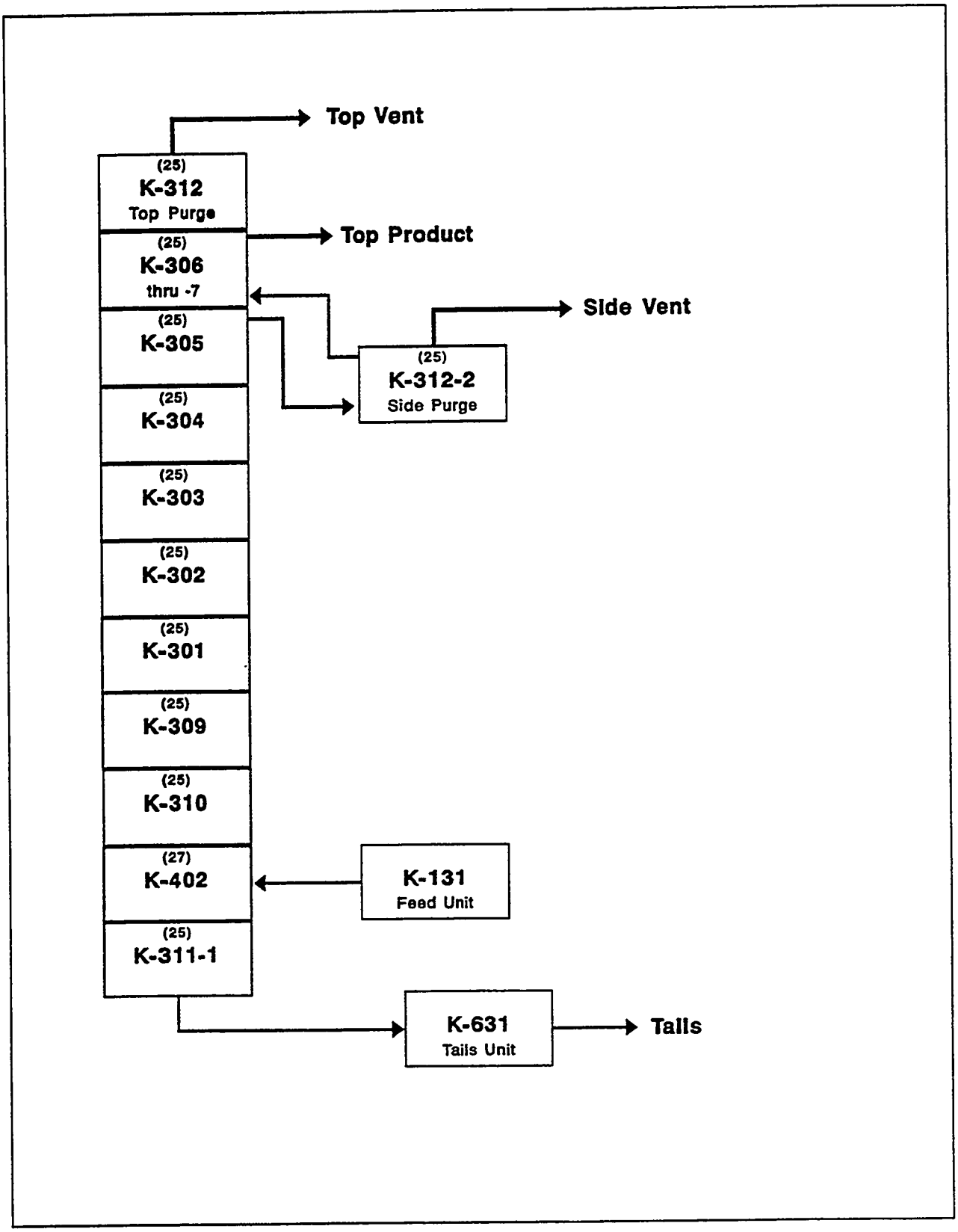

Figure B-3. Schematic Process Flow, 1948-1951

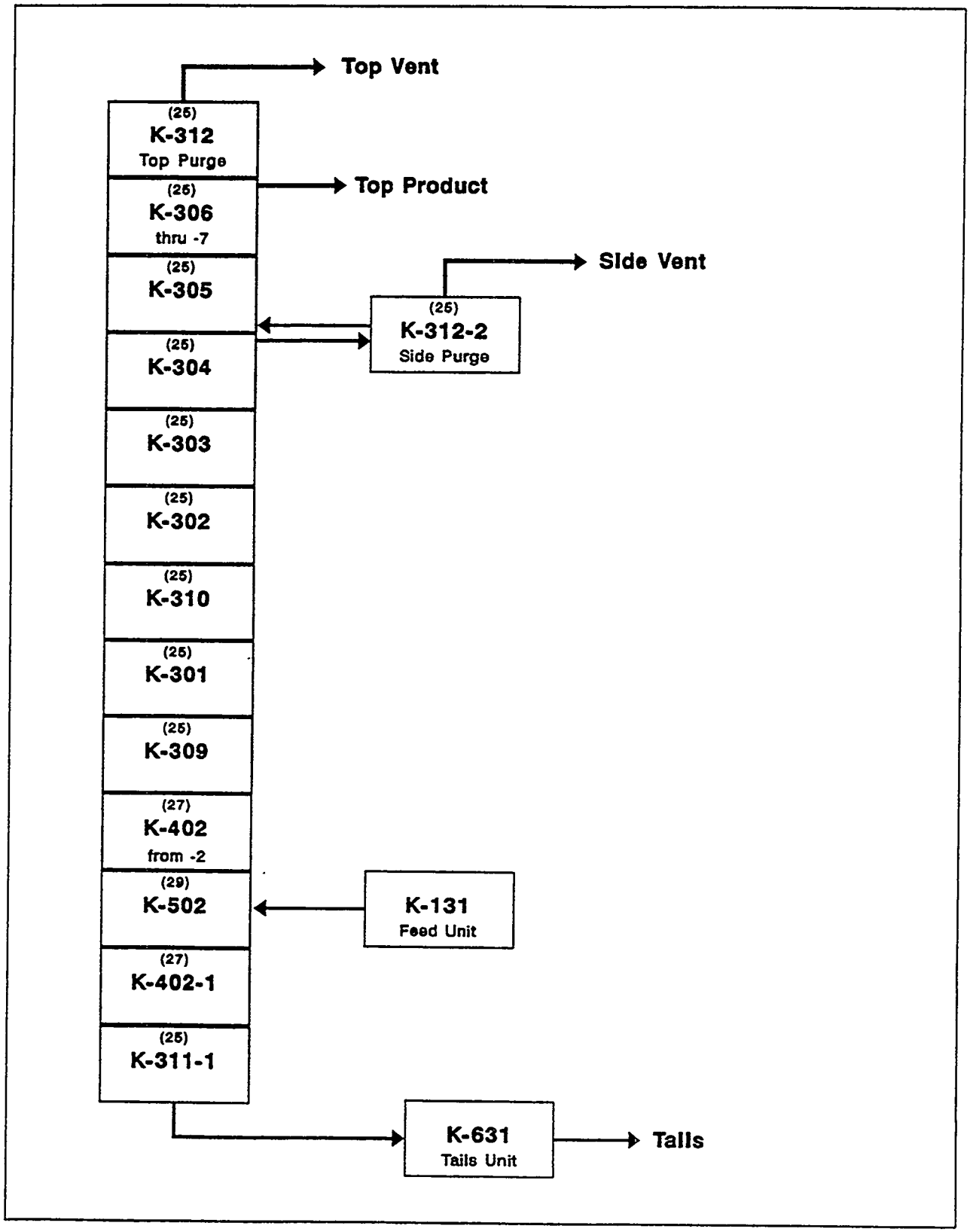

Figure B-4. Schematic Process Flow, 1951-1952

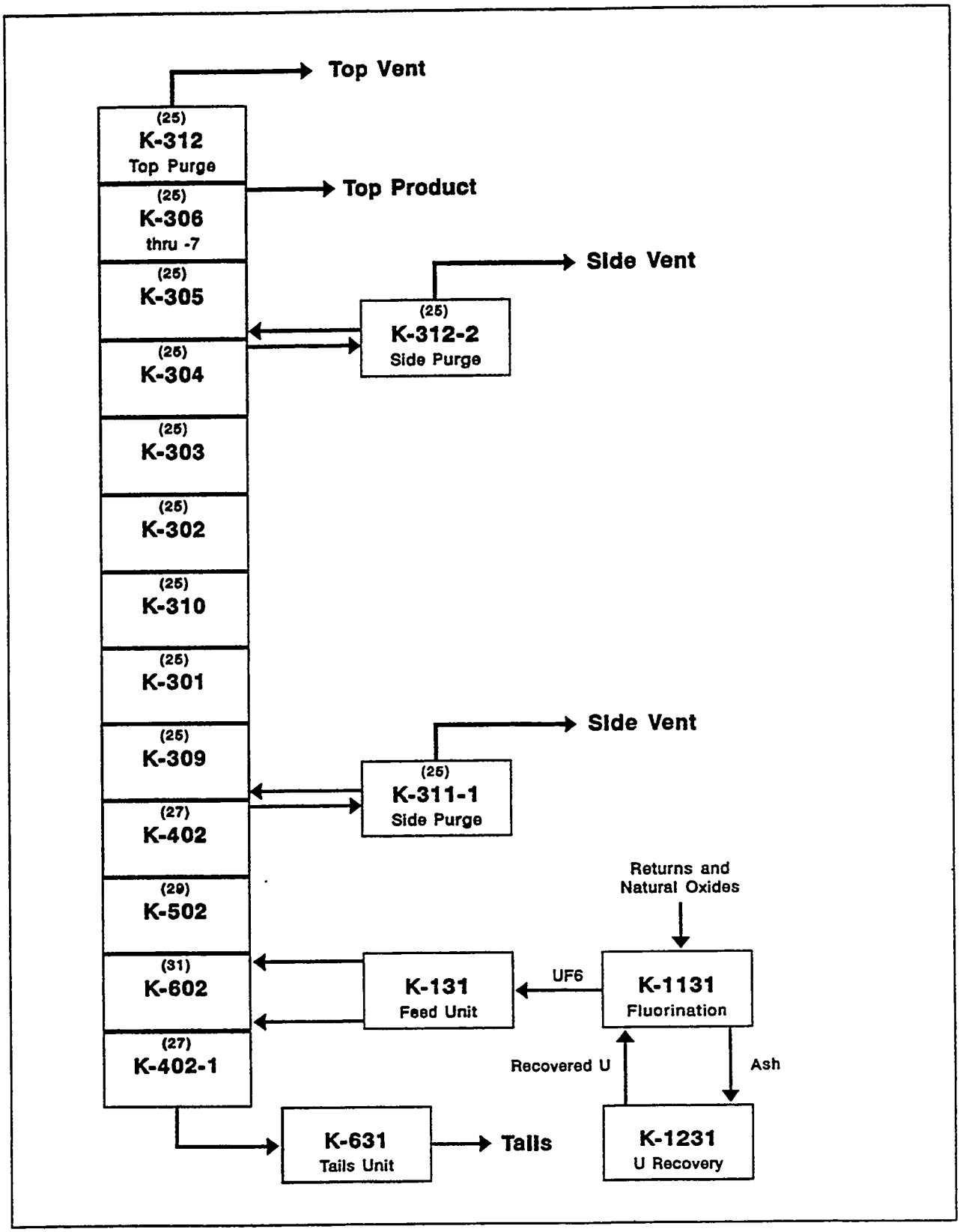

Figure B-5. Schematic Process Flow, 1952-1954

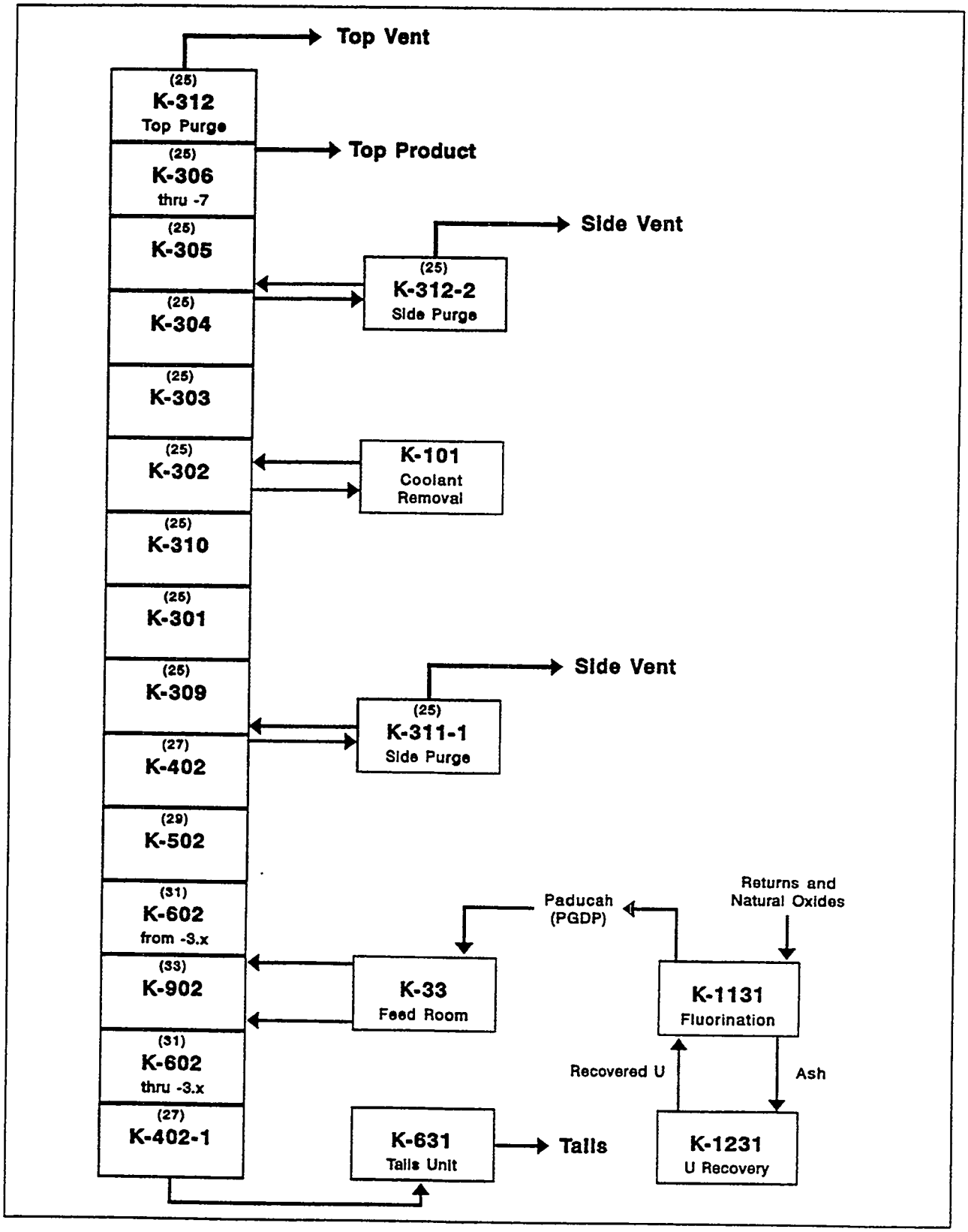

Figure B-6. Schematic Process Flow, 1954-1957

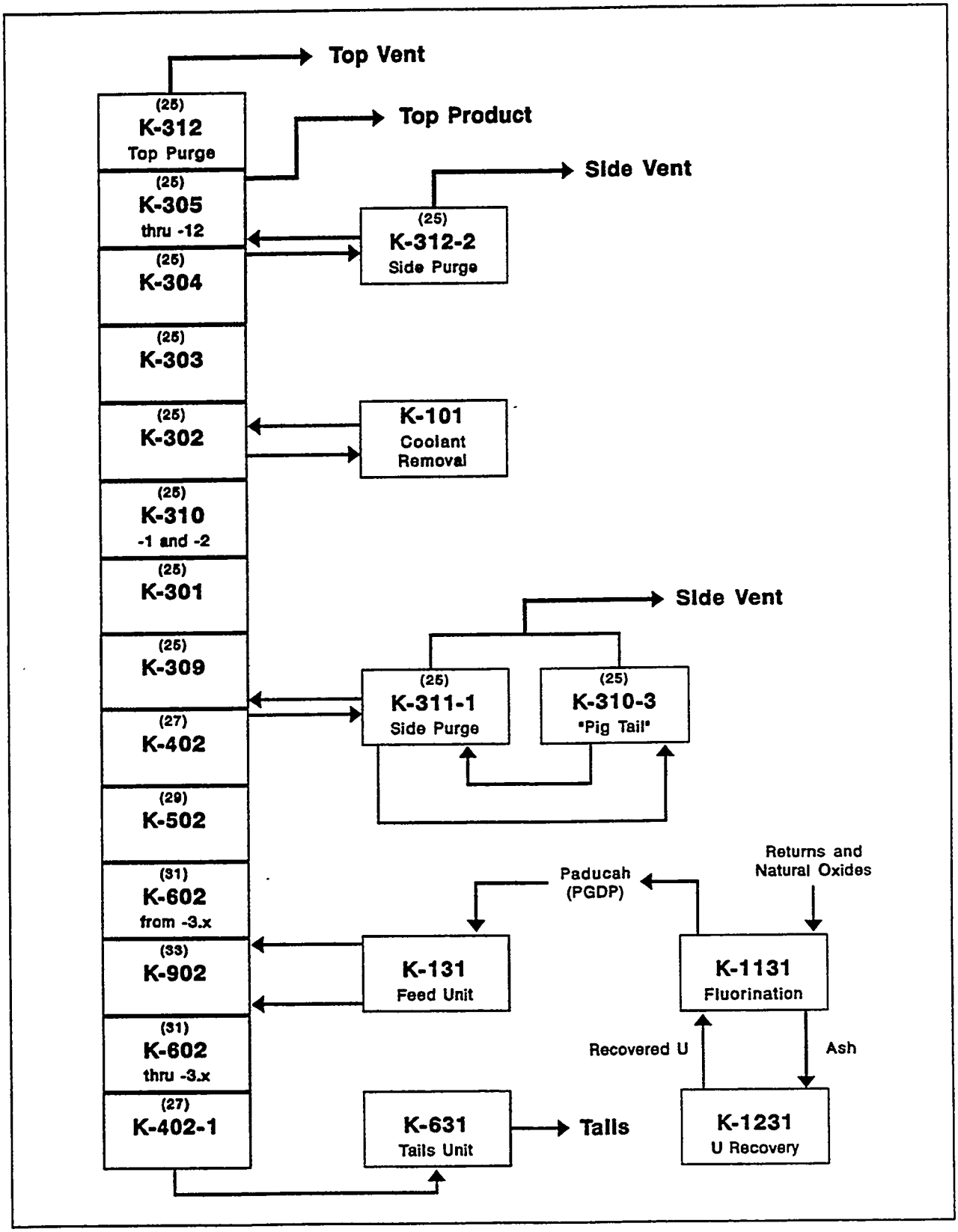

Figure B-7. Schematic Process Flow, 1957-1959

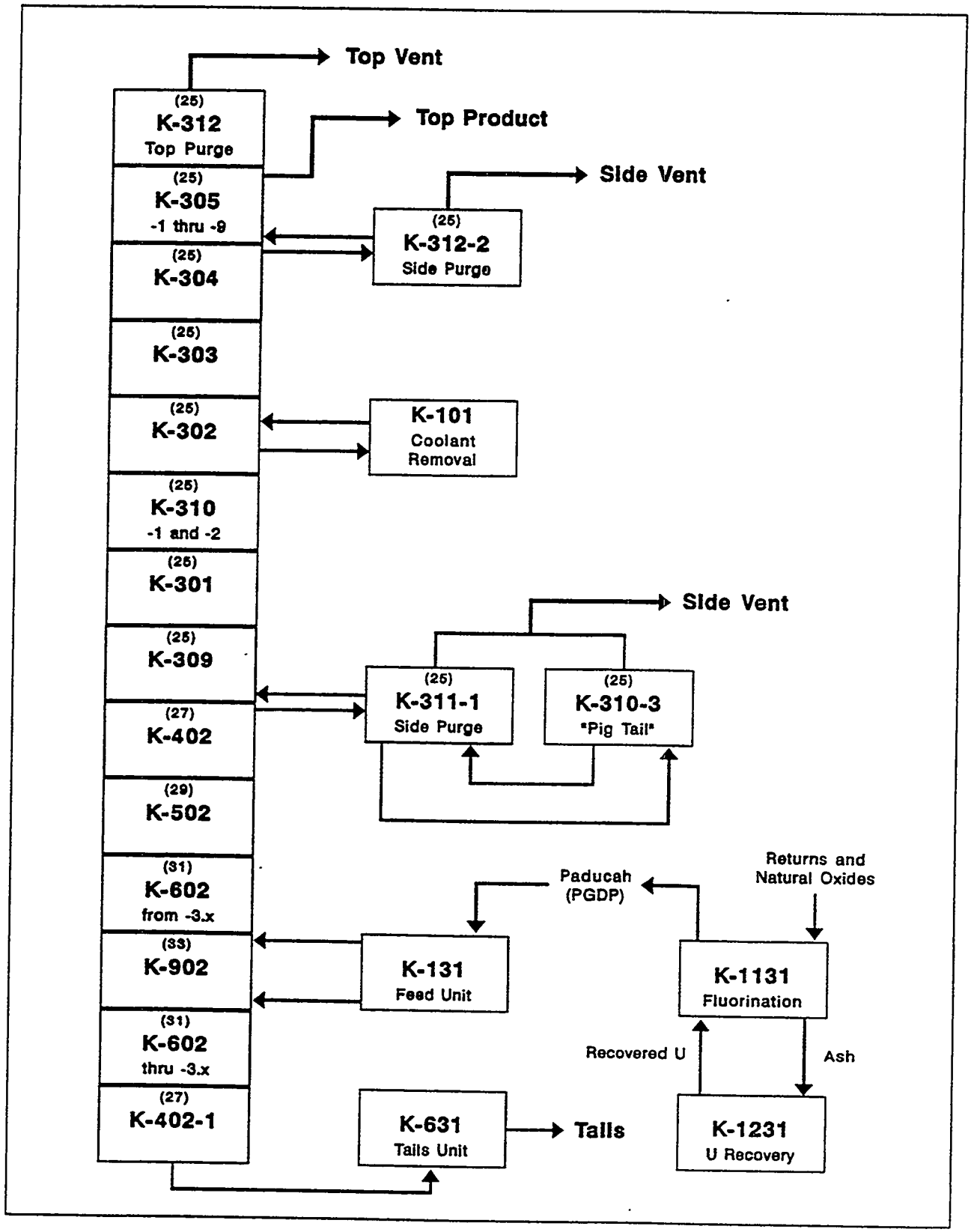

Figure B-8. Schematic Process Flow, 1959-1961

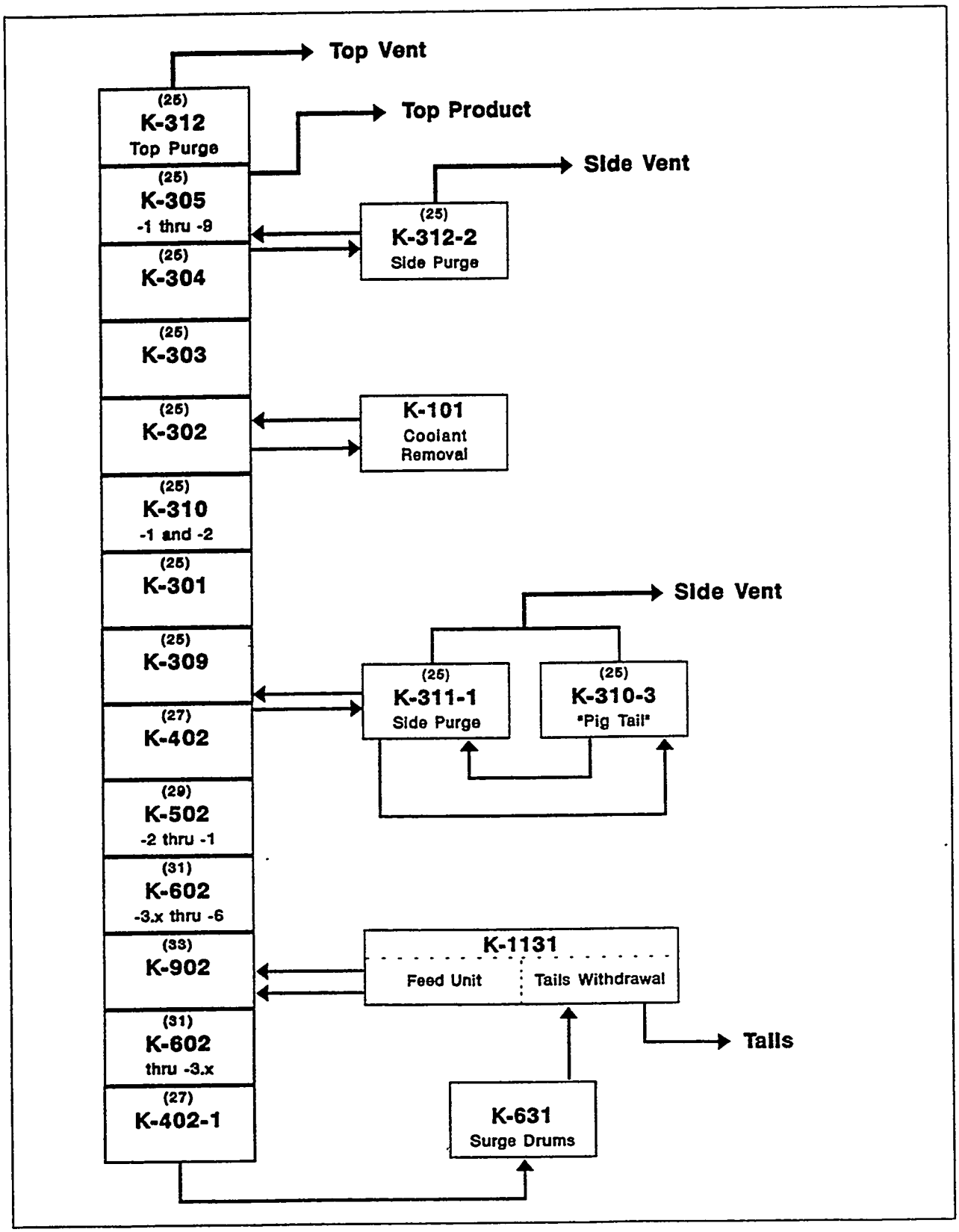

Figure B-9. Schematic Process Flow, 1962-1964

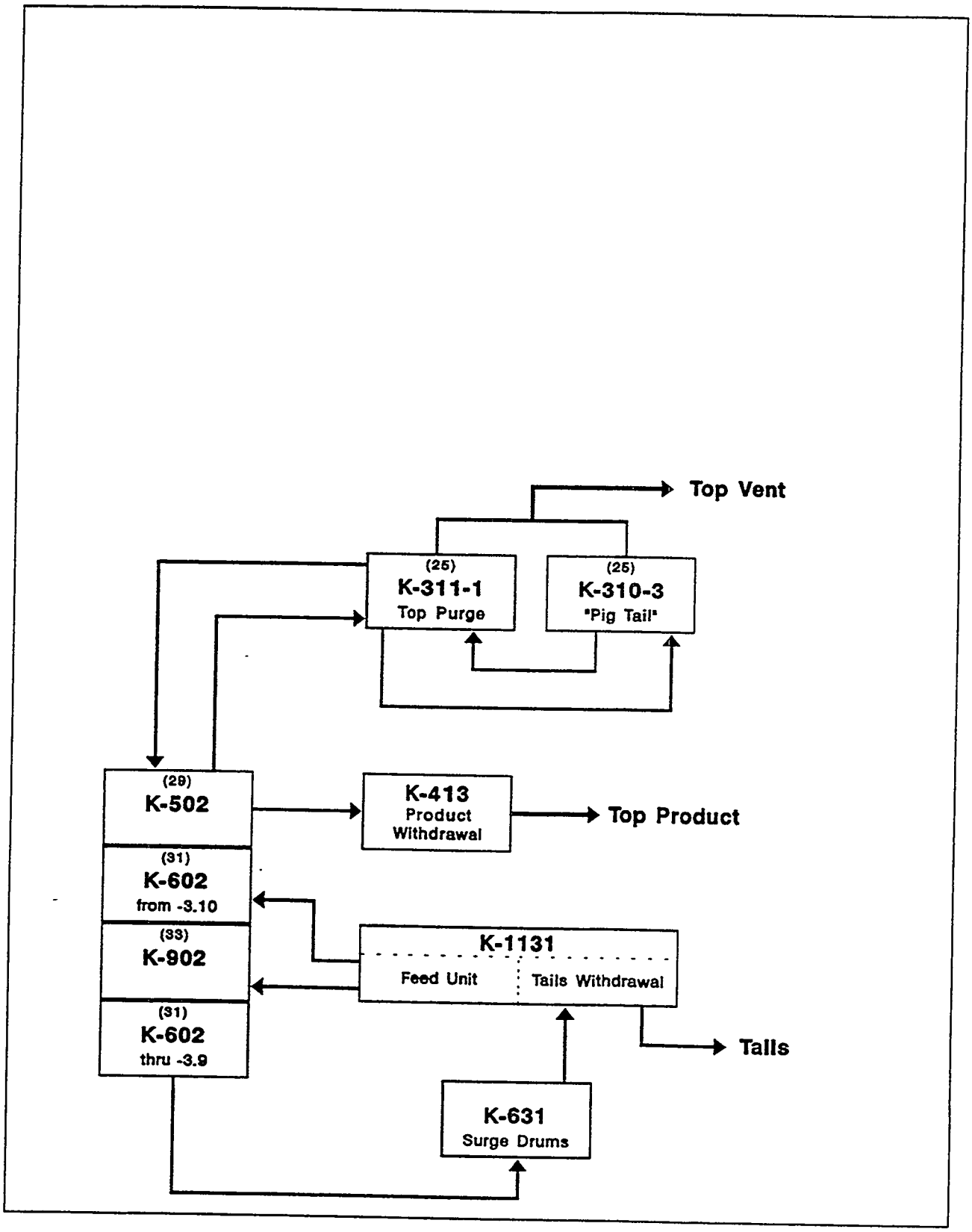

Figure B-10. Schematic Process Flow, 1964-1977

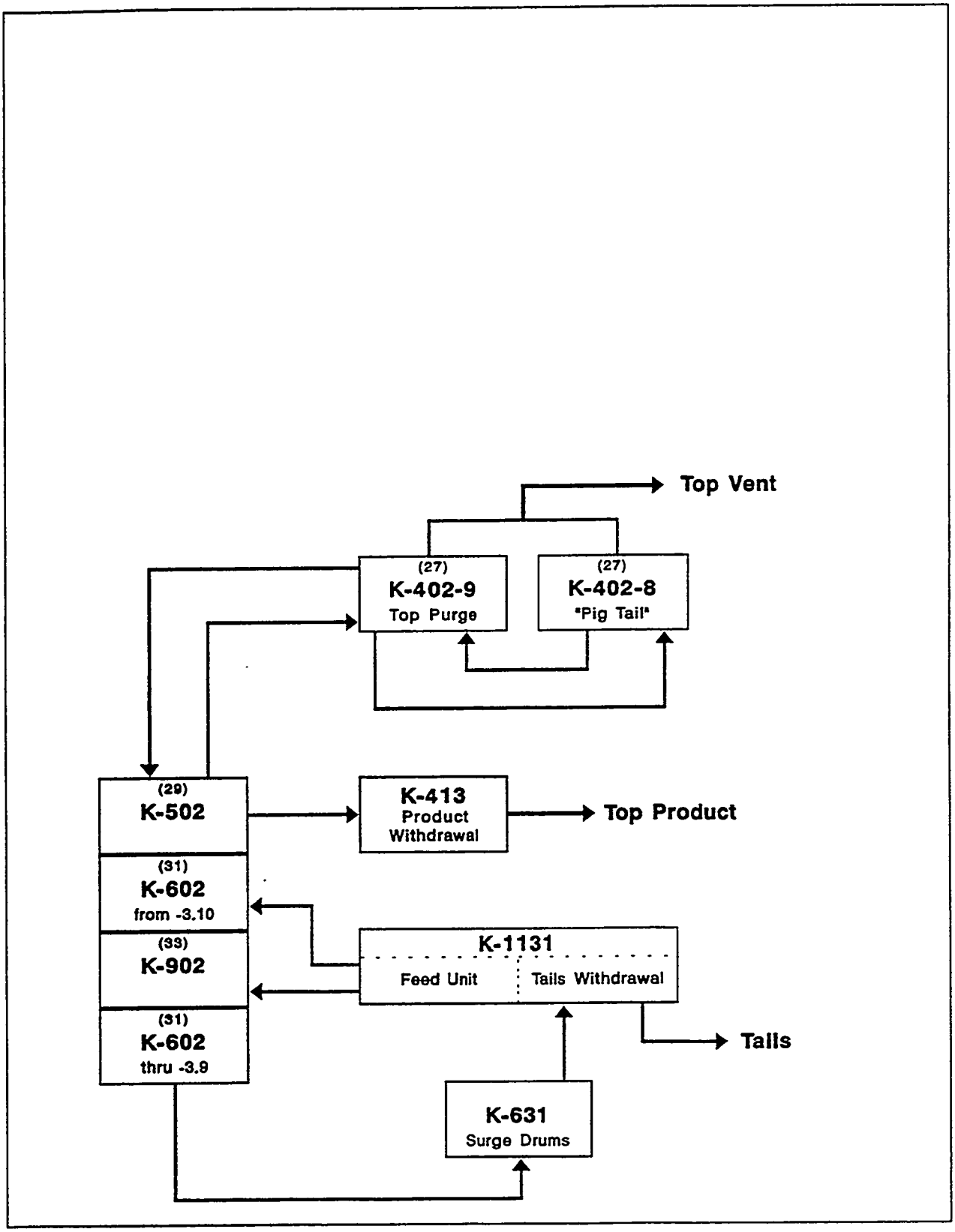

Figure B-11. Schematic Process Flow, 1977-1985